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THE

JOURNAL OF SCIENCE.

MARCH, 1885.

I. THE HEAT OF THE SUN.

By ERNEST H. COOK, B.Sc. (Lond.), A.R.C.S., F.C.S.

WHEN we consider the magnificence and beauty which, under favourable conditions of the atmosphere, the heavenly bodies exhibit, it is a matter of no surprise that the most brilliant and grandest of them all should have attracted and rivetted the attention of the earliest philosophers. Accordingly we find in the very first pages of the world's written history, under the influence of an Eastern Sun, that those Chaldean shepherd astronomers speculated as to the constitution and position of the central luminary. Long before the enormous distance of the Sun was approximately fixed, speculation began to be made to attempt to account for the source of the enormous amount of heat which is given out by the Sun. The first and most unscientific of these theories of the source of the Sun's heat (that of combustion) was propounded before any actual experiments had been made as to the exact amount of heat which is constantly given out. Thus attempting to explain and account for something which was not known, it is not to be wondered at that subsequent discovery and investigation have shown the utter inadequateness of this first assigned cause of the Sun's heat. Before we state and examine the various theories it is necessary for us to thoroughly understand and appreciate the vastness of the action we have to account for.

The distance which separates us from the Sun has been determined with very great accuracy, because of its importance to astronomers, this distance forming their unit of length. With tolerable accuracy we may take this as equal to 92,000,000 of miles. Although this distance is infinitely small when compared with the distances of many of the stars which are familiar to astronomers, it is yet so great compared with our ideas of distance that we can form no conception, however remote, of it. Fortunately, however, we are now dealing not with conceptions and imaginings, but with bare and unvarnished facts. Knowing this distance, knowing also the apparent magnitude,—*i.e.*, the observed diameter of the Sun,—it is easy to calculate his real diameter. This has been found to be approximately given by 880,000 miles. These distances being determined, and the fact established that the planets revolve round the Sun, it follows that there must be some force pulling these planets, emanating from the Sun, which causes them to revolve around it. This force we know to be that of gravitation. Again, the period which it takes for the Earth to revolve around the Sun is given by the length of what is called a mean solar year. It is also known that the length of this mean solar year has not altered during the period of recorded astronomical observation. It therefore follows that the force pulling the Earth, and keeping it in its orbit, is just sufficient to do so and no more. For if the Sun's force acting upon the Earth were more than just sufficient to do this, the year would be gradually diminishing in length by an amount which would be proportionate to this excess of force. In short, the Earth would be gradually approaching the Sun. If, on the contrary, the force were less than just sufficient to do this, the year would be gradually increasing in length: in short, we should be receding from the Sun. Observations extending over a great number of years prove that neither of these things is occurring. Now if we know the mass of a body which is moving in a certain orbit, if we know the radius of that orbit, and also the velocity with which the body is moving, we can find, by employing a formula well known to scientific men, the force which is emanating from the centre, and which is just able to keep the body from moving out of that orbit. Calculating in this manner, it has been deduced that the attraction which the Sun exerts upon our globe is equal to that which would be exerted supposing it to consist of 360,000 earths rolled into one. Now we have just seen that the diameter of the Sun is 880,000 miles; that of the Earth is 8000; thus the Sun's

diameter is about 110 times greater. The bulk or cubic capacity of the Sun is therefore the cube of 110, or 1,331,000 times that of the Earth. But the mass, calculated from the attraction which it exerts, is only 360,000 times greater, —consequently the materials of which the Sun is composed must be much lighter than those which compose our Earth. Speaking accurately and scientifically we should say that if the density of the Earth be taken as unity, that of the Sun is only 0·250; or if, as experiment shows, the mean specific gravity of the Earth is equal to 5·2, then that of the Sun is equal to 1·3.

Having now fixed some of the physical constants of the centre of our planetary system, we have to determine the amount of heat which is given out. In the first place, it is evident that we who live upon the Earth must necessarily make our observations upon the Earth; it is thus important that we should know what fraction of the total amount of heat emitted by the Sun is absorbed by the Earth. The radius of the Earth's orbit, we have already seen, may be taken as 92,000,000 miles; the circumference of the approximate circle which is described around the Sun is thus equal to 3·1416 × 92,000,000 × 2, or about 578,000,000 miles. The diameter of the Earth is about 8000 miles; consequently the Earth occupies about the 73,000th part of the circumference of the approximate circle which it describes around the Sun. But this refers only to one plane. Taking the area of the hollow shell surrounding the Sun at a distance of 92,000,000 miles as equal to 115,000,000,000,000,000 square miles, and taking the Earth as a flat plane 8000 miles in diameter, or 50,000,000 square miles in area, we find that the Earth intercepts the 2,300,000,000th part of the total heat emitted by the Sun. If, then, we find the quantity of heat received by the Earth, and multiply it by this last number, we shall obtain the actual heat given out by the Sun.

By allowing the rays from the Sun to fall perpendicularly upon a surface which is capable of absorbing them, and warming a known quantity of mercury, the heating power of the Sun has been determined. Two series of observations on this point have been made: one at Paris by M. Pouillet, with his pyrheliometer; and the other at the Cape of Good Hope by Sir John Herschell, with his actinometer. The results are concordant, and they give that the amount of heat received by the Earth in one year would be capable of liquefying a layer of ice entirely surrounding the Earth to a depth of 100 feet. This, then, is the amount of heat

which falls upon an area of 50,000,000 square miles; multiplying this by 2,300,000,000 we obtain the total amount of heat emitted by the sun. In speaking of the distance of the Sun it was stated that we could form no idea of the vastness of the distance which separated us from him. And, if it is impossible to form an idea of the distance, it is also equally impossible to form an idea of the immense heat which he possesses. The highest temperatures which we can obtain are so cold compared to his temperature that the comparison between an Arctic winter and an Equatorial summer is quite inadequate to represent the difference. Thus Prof. Tyndall says—"The heat emitted by the Sun, if used to melt a stratum of ice applied to the Sun's surface, would liquefy it at the rate of 2400 feet an hour. It would boil per hour 700,000 millions of cubic miles of ice-cold water."

Another eminent writer upon this subject, Sir John Herschell, says "that the heat thrown out from *every square yard of the Sun's surface* is equal to that which would be produced by burning on that square yard 6 tons of coal per hour, and keeping up constantly to that rate of consumption. And this, mind, on each individual square yard of that enormous surface which is 12,000 times that of the whole surface of the Earth."

In attempting to bring the imagination to grasp such enormous numbers and statements we are attempting a hopeless task; it recoils from such immensity much as a billiard ball recoils from the cushion upon which it strikes. But although thus unable to appreciate such facts the reasoning powers of many (I may perhaps say most) scientific men have been employed from time to time for the purpose of seeking a *cause* which shall be a sufficient and a possible one to account for this enormous expenditure of power,—an expenditure, be it remembered, which has been going on, at least during historic times, without the slightest diminution.

The theories which have been proposed from time to time we will now examine, taking them in the order of their age, and impartially examining each.

The Combustion Theory.

This is the oldest, simplest, and most unscientific of the whole. It cannot be ascribed to any author, and in fact it is probable that most thinkers upon the subject, upon a first and superficial examination, would propound such an explanation. Shortly expressed it says that the Sun is a fire,

differing only from our terrestrial fires in magnitude and in the intensity of its combustion. Now as the substance which we use most extensively, and which gives us more heat than any other common substance, is carbon, consequently it has been suggested that the Sun consists of a mass of carbon in an active state of combustion. This, then, is the first crude idea which was held respecting the constitution of the Sun. Before we allow ourselves to wonder at the authors for proposing so unsatisfactory an explanation, we must bear in mind the "nature of the environment," if I may so call it, in which they were placed. In the first place the distance of the Sun was not thought so immense as it is now proved to be; secondly, the age of the Earth was not considered so great as at present,—consequently a less powerful cause had to be found; and thirdly, those wonderful discoveries of the spectroscope which have revealed to us the physical construction of the Sun had not been made.

Now in order that combustion, as we term it, should go on, there must be some substance with which the combustible body can combine. Here on our Earth this body is known to be oxygen, and it is supposed that the same body exists in the Sun, and by its combination with the carbon produces the heat which we find given out. Again, we know that 1 lb. of pure carbon, in burning so as to produce the greatest amount of heat, combines with $2\frac{2}{3}$ lbs. of oxygen. Also one cubic mile of pure oxygen will weigh about 13,189,120,000 lbs. Now on every square yard of the Sun's surface there is given out as much heat as would be produced by the burning of 6 tons of carbon per hour: 6 tons of carbon will require 35,840 lbs. of oxygen, and such an amount of oxygen would be contained in a column 1 square yard base and 14,336 yards high. Thus in every hour the Sun uses up a column of pure oxygen 8·3 miles high, and of the density of the gas at the average atmospheric pressure here on the Earth. But the attraction of the Sun upon any body placed near it is, in consequence of its mass, very nearly thirty times as great as the attraction of the Earth upon the same body. We will thus reduce the height of this column this number of times, and thus obtain that every hour there is used up a shell of about 3-10ths of a mile thick around the Sun of pure oxygen. (This difference in attractive power is only mentioned to guard against misrepresentation, and for the purpose of making the latter part of the argument more conclusive.) The immense heat of the Sun would expand gaseous bodies so much as to

counterbalance the effect of the increase of gravitation. Moreover, as we recede from the Sun the attractive force diminishes, according to the well-known law of the square of the distance, and therefore the density of the imaginary atmosphere also decreases. But if this is the amount used up in one hour it is easy to calculate the amount used up in any number of hours or years. We thus find that in five thousand years the height of the atmosphere of pure oxygen consumed would be 13,240,000 miles high, *assuming* the density the same as that which it would have at the *surface of the Sun*. If, however, we consider, since pure oxygen is a most unlikely substance to exist in such quantity, that the solar atmosphere consists of the same materials as the terrestrial one, in fact that it is only part of the universal atmosphere,—an assumption which has been made, and which is highly probable,—then the height of the atmosphere required for a period of five thousand years becomes 66,200,000 miles. This distance is much greater than the distance of the planet Mercury, and is about equal to that of Venus, from the Sun.

We therefore see that, examining the theory in this way (which the author believes to be a novel one), we are called upon to assume the existence of a solar atmosphere extending up to the planet Venus, and possessing a density thirty times as great as that of the Earth at the sea-level. And this immense volume is required for the comparatively short period of five thousand years. Taking Croll's estimate of the age of the Earth as 20,000,000 of years, we must extend the atmosphere about a hundred times as far as the orbit in which the most remote member of the planetary system revolves. It is needless to say that such a state of things is impossible, for the retardation which the planets would suffer would most assuredly have been discovered long before this, and it is probable that owing to such retardation one or more of them would have fallen into the Sun.

I have selected this method of viewing the combustion theory because the conclusions drawn from it are so obviously impossible. It can, however, easily be shown that, at the rate of burning necessary, a block of pure carbon of the size of the sun would be burnt out in about five thousand years. We can also ask, What becomes of the products of combustion? Where is the carbonic anhydride stored away? These and other questions impossible to answer compel us to at once put aside the combustion theory as not only untenable, but impossible.

Many modifications (if we may so call them) of this

theory have been proposed, but they all fail to afford an adequate cause. Thus the suggestion has been made that the oxygen needed for combustion may be supplied from the material of the Sun itself, just as gunpowder is supplied with oxygen from the nitre it contains. But even supposing him to consist of gun-cotton, the substance which is better supplied with oxygen than any other, it is easily calculated that he would be burnt out, and

> . . . . "wander darkling in th' eternal space,
> Rayless and pathless,"

in less than eight thousand years.

These various suggestions—for we cannot call them theories—we will not stop to consider. Ingenious and yet simple, as many of them are, they one and all fail to rise to the magnitudes with which they have to deal. We pass on to the consideration of the next, and certainly one held by many physicists.

The Meteoric Theory.

Born in the little town of Heilbronn, Würtemberg, the illustrious originator of this theory would have lived and died a respected German physician had he not possessed a strong mental bias in favour of physical speculations. In such a case the strong influence which his writings have made upon the thought of the present day would have been wanting, and the world would have been ignorant of the name of Robert Julius Mayer. But here we must guard ourselves against falling into the opposite extreme, and giving all the credit to one. I have called Mayer the *originator* of the theory, and so in truth he was, having published his "Essay on Celestial Dynamics" in 1848. But, as is generally the case, other minds were at the same time actively engaged upon a similar subject. It was not, however, until the Hull Meeting of the British Association, in 1853, that Waterton sketched the same theory, being at the time quite ignorant of Mayer's previous writings. Waterton's paper attracted the attention of the celebrated mathematician and physicist, Sir William Thompson, and in a beautiful memoir—published in the "Transactions of the Royal Society of Edinburgh" for 1854—the whole theory is exhaustively worked out and developed. With the help of these writings we will now endeavour to give, as briefly as possible, an outline of this interesting theory.

It is necessary, however, to a proper appreciation of the

subject to acquire a little preliminary knowledge. Suppose a body to be moving and we stop that body's motion, we know that we have to exert force to do so. Moreover, the heavier the body the greater force is required, or, with the same weight, the faster it goes the more force is required. Given the weight and the velocity of motion, we can calculate the work required to be done to bring the body to rest. Again, it has been proved that work or energy and heat are mutually convertible,—*i.e.*, that a certain amount of heat can be produced by the expenditure of a certain amount of work, and also that a certain amount of work will heat a given body to a certain degree. This has been called the Mechanical Equivalent of Heat, and we may state it thus: —If the work required to raise 1390 lbs. one foot high be done upon 1 lb. of water, the temperature of that water will be raised 1° C. Now, as was said above, we can calculate the amount of work which must be done in order to stop the motion of a moving body, and therefore, if this work be transformed into heat, we can find how much the temperature of the body will be increased. Thus we find that the heat given out by stopping the motion of a leaden bullet moving at the rate of 1300 feet a second would raise its temperature about 600° C., if all the heat were retained by the bullet.

To the imagination it is an easy matter to rise from the consideration of the impact of a rifle bullet to consider the impact of worlds. In effect this is what the Meteoric Theory does, only instead of worlds it considers the collision to occur between the Sun and meteors and comets. In our solar system there exists a numerous class of small bodies called asteroids. These small bodies, like the larger ones, are subjected to the law of gravitation, and are attracted by the Sun. Any medium which exists in space, however rare it may be, would exert a comparatively greater action upon small bodies than upon large ones, such as the planets.* Thus, although these latter may not have their motions affected, the former may be rapidly caused to approach the Sun. It is thus supposed that the Sun is constantly subject to a cannonade of small bodies upon its surface. But if such a rain of these small bodies is constantly falling from the outermost limits of our system upon the Sun, it is evident that as they approach near him they become condensed. We ought therefore to be enabled to see such a crowd of

* It is interesting to note here that the idea of the universal existence of the atmosphere is introduced in the Meteoric Theory.

meteors before they fall into the Sun. This is supposed to be proved by the existence of the mass of hazy matter which surrounds the Sun, known as the Zodiacal Light. Whether or not this consists of an assemblage of meteors it is, of course, impossible to say; but the matter composing it has been shown to obey the ordinary laws of planetary rotation, and thus to behave exactly as meteors would.

There are two ways in which a body may fall into the Sun: it may fall directly upon it, or it may revolve around it in gradually diminishing orbits until it is at last absorbed. The final velocity which it would have is very different in the two cases; in the first, supposing it to fall from an infinite distance, it would have the greatest velocity possible, *viz.*, 390 miles a second. In the second case, where the velocity may be supposed a minimum, it would be equal to 276 miles a second. Striking the Sun with its maximum velocity, the body would generate "more than 9000 times the heat generated by the combustion of an equal" amount of coal. Striking with its minimum velocity, it would produce 4000 times as much heat.

"Here, then, we have an agency competent to restore his lost energy to the Sun, and to maintain a temperature which far transcends all terrestrial combustion. . . . It may be contended that this showering down of matter necessitates the growth of the Sun: it does so, but the quantity necessary to maintain the observed calorific emission for four thousand years would defeat the scrutiny of our best instruments."—(Tyndall.)

The amount of heat generated by the fall of these meteors is thus undoubtedly sufficient to produce the temperature we find, and there also can be no doubt as to the number of these bodies existing in the Solar System. When we remember the large number of meteors which are seen by observers, also that the vast majority can only be seen at night, and the small bulk which the Earth occupies in space, we cannot but admit the sufficiency of the cause in regard to quantity. Thus during one observation at Boston there were observed, in nine hours, no less than 240,000 meteors; and thus in a year we may conclude that hundreds, perhaps thousands, of millions fall into the Earth's atmosphere.

Sir William Thompson, in developing this theory in the paper before mentioned, has modified it somewhat. His first idea was similar to that of Mayer, that the meteoric matter raining down on the Sun circulated close to him. But if there be this matter existing round the Sun, it is difficult to account for the fact that comets are observed to

pass quite close to him, and therefore through this matter, without suffering any loss of energy. Thompson has therefore come to the conclusion that the heat of the Sun was *produced* in this way, but is not thus *maintained*. He considers "the low rate of cooling, and consequent constancy of the emission, is due to the high specific heat of the materials of which the Sun is composed."—(Tyndall.) Thus in effect the Sun is cooling down; but at the enormous rate at which he gives out heat, according to our knowledge of terrestrial things, we should imagine he would soon be burnt out. But this notion, if it exists, must be dispelled, as Thompson proves that the heat thus originally produced is able to supply the Sun with sufficient to last him for no less than 20,000,000 years.

But although dealing with small masses of matter, this theory is not confined to them. The heat may be produced by larger masses striking the Sun. In the history of astronomical observations we have it set down that occasionally stars are observed to suddenly increase in brilliancy until they reach a maximum, and then to decline until they reach their former brightness. Thus in 1572 an entirely new star suddenly "appeared in the constellation Cassiopeia, and gradually increased in brilliancy until it surpassed all the other stars. It could be plainly seen in the daytime. On a sudden, November 11th, it was as bright as Venus at her brightest. In the following March it was of the first magnitude. It exhibited various hues of colour in a few months, and disappeared in March, 1574."—(Draper.) Since then many similar occurrences have been noted. These can only be satisfactorily explained by supposing a collision between two bodies to have occurred. Acting upon this idea Sir W. Thomson has calculated the heat which would be given out by the various bodies composing the planetary system falling into the Sun. The table is as follows, the heat being expressed as able to sustain the solar emission for the stated times:—

Mercury	6 years 214 days.
Venus	83 ,, 227 ,,
Earth	94 ,, 303 ,,
Mars	12 ,, 252 ,,
Jupiter...	32'240 ,,
Saturn...	9659 ,,
Uranus	1610 ,,
Neptune	1890 ,,

Thus if the Earth were to fall into the Sun the heat which would be given out by the sudden stoppage of the motion would be sufficient to keep up the present rate of solar emission for a period of 94 years 303 days. In addition to the amounts given in the Table there must be added the heat which would be produced by the stoppage of the rotation of the planet on its axis, which in the case of the Earth would supply the Sun for 81 days. "The heat of rotation of the Sun and planets, taken together, would cover the solar emission for 134 years, while the total heat of gravitation (that produced by the planets falling into the Sun) would cover the emission for 45,589 years."—(Tyndall.)

In the foregoing sketch of a theory which has influenced so mightily the progress of solar physics, I have endeavoured to confine myself as much as possible to the words of its authors and supporters. In taking a survey of it in its entirety we cannot but be struck by the really beautiful way in which everything is derived from one original and all-pervading law—that of gravitation.

Given the existence of matter and the law of gravitation, the theory shows how the universe may have been produced. The same force which causes the apple to fall to the ground, acting through distant ages, gave us the light and heat of the Sun which caused the apple to ascend on the tree. Unity and design pervades the whole, and this is what we find everywhere in Nature.

Again, throughout the whole of the theory there is no assumption of either hypothetical substances or hypothetical forces; no luminiferous ether with its Protean properties, the single blot on the Undulatory Theory of Light; no attractive and repulsive zones, as in the Corpuscular Theory. Starting with matter as we find it on the Earth, it works out its results according to the operations of known and thoroughly established laws. This is an important point, for the theory was propounded and worked out long before Kirchhoff had given to the world his immortal discovery of the existence of terrestrial matter in the Sun. Subsequent discovery proves that the universe contains no matter not existing on the Earth, and the Meteoric Theory calls for no other.

What I may call the essential elements of a theory are therefore here present; its ultimate fate must therefore depend upon some more probable explanation being proposed. We rightly consider the prediction of a hitherto unknown phenomenon, which is afterwards proved to be true, as a triumph of theory. Thus the discovery of Neptune and

that of Conical Refraction are considered as having fixed the Gravitation and Undulatory Theories respectively on a firm basis. It happens that the Meteoric Theory has also its prediction. Owing, however, to its nature we are and shall be unfortunately unable to verify it. The prediction is nothing more nor less than that of the end of our planetary system, and in fact of the universe. Moons will fall into planets, planets into suns, and suns into other suns, and at the last only one mighty sun will remain. This is the end to which all must come.

In taking leave of this theory I cannot omit to mention one important point which I do not think has been raised before, and which, so far as I am aware, has not attracted the notice of its supporters. It will be seen that one of its assumptions is that the central body is gradually, although very slowly, attracting the revolving bodies nearer to itself. Extending this idea very slightly, we have that the planets acting as central bodies ought to be gradually attracting their satellites. This point has been fully and ably worked out by Mr. G. H. Darwin, and he has come to the conclusion that the Moon has been, and still is, gradually receding from the Earth. Upon this point, therefore, theory and observation seem to be opposed to each other, and we shall be glad to see the explanation of the supporters upon it.

The Contraction Theory.

In the above statement of the Meteoric Theory it is pointed out how comparatively small an addition to the bulk of the Sun is able to support the loss of energy which he suffers. But although undoubtedly the amount which has fallen during historic times is small compared to the immense bulk of the Sun, yet when we consider geologic times the case is different. The additions which the Sun has received during these times must have caused a great change in the periods of planetary revolution; and it is hardly possible to avoid the conclusion that, if such is taking place, some evidence of it would have been found ere this. Considerations somewhat of this nature induced the great German philosopher Helmholtz to discard the theory, and to propose in its stead one founded on the heat given out by the contracting of the body of the Sun, and hence called the Contraction Theory. Speaking of this theory in a recent lecture at New York, Prof. Young, of Vermont, says:—"It is the one held by most scientific men, and is one which I think will be found more than half true." Without

entirely endorsing Prof. Young's words, there can be no doubt that we have in it a thoroughly competent cause to produce the effects.

Starting at the beginning, Helmholtz assumes the truth of Laplace's great conception known as the Nebular Hypothesis. This theory supposes, as is well known, that at one time—millions of years ago—the whole of the matter composing the various members of the solar system, together with any interplanetary substance which may exist, was diffused in space in the form of highly rarefied gas. The only known cause capable of keeping such materials in such a condition is heat, and it is thus further assumed that the whole of the heat in our system, together with a large quantity which has been wasted in space (*i.e.*, space beyond the confines of the orbit of Neptune), was stored up in the nebulous matter in the form of latent heat. This highly rarefied matter gradually radiated its heat into space, and in consequence began to diminish in bulk, and at the same time to increase in specific gravity. Planets and satellites began to form out of it, and the process of cooling and contraction continued until the system assumed its present condition. In this process, assuming the specific heat of the condensing matter to be equal to that of water, Helmholtz calculates that the heat given out would raise the temperature 28,000,000° Centigrade. What, then, has become of this immense amount of heat? All of it, except a very small fraction, has been radiated into stellar space, and lost amid the vast recesses which practically exist between suns or between the satellites of suns. The small fraction has been intercepted by the matter of some of the planetary bodies, and its energy, or some portion of it, used up in rearranging the materials of the planet. In this way, perhaps, the vast store of energy which the deposits of carbonaceous matter in the Earth possess, may have been derived from the condensation of the nebulous matter, and was employed at one time in keeping the molecules of that substance in a state of vibration. But the process of condensation having gone on from the remotest times up to the present does not stop here. Helmholtz supposes it to be still going on, and in this way he accounts for the heat which we and our fellow-worlds derive from the Sun. According to this theory the central orb is radiating heat into space at the enormous rate indicated at the commencement of this paper, and is being cooled by the loss thus experienced. In consequence of this cooling the materials composing the Sun must occupy less space, and consequently its diameter become less.

Moreover, the more rapid the shrinkage the greater the amount of heat radiated; or, in other words, knowing the amount of radiation taking place, the weight and volume of the radiating body, and its specific heat, it is possible to calculate the rate of shrinkage necessary to keep up the energy expended. Without going farther the superficial reader would at once discard the theory as untenable. "Here," he would say, "you have the Sun emitting radiant energy at this enormous rate, which has demonstrably not diminished during historic times, and has probably continued for 20,000,000 years; and all produced by the shrinkage of his substance. Why long ere this he would have shrunk into a cold dead mass." But let no one imagine the celebrated German guilty of want of care in examining the subject. He has made the calculation indicated above, and he proves that a shrinking of the Sun's diameter by 1-10,000th of its present length (*i.e.*, 88 miles) would produce an amount of energy capable of keeping up the solar emission at the present rate for two thousand years. But if the Sun be supposed to go on contracting, and its specific gravity to go on increasing until it equals that of our Earth, then Helmholtz shows that the heat evolved would supply the Sun with energy for no less than 17,000,000 years!

In brief outline this is the celebrated theory of Contraction. Simple in its assumptions, and quite competent to fulfil the demands made upon it, it is not a matter of surprise that it is held by many of the first thinkers of our time. Yet we cannot help thinking that two considerations weigh heavily against it. First, the researches of modern spectroscopy seem to indicate that we have in the Sun an intensely hot nucleus, surrounded by an atmosphere or shell of less intensely heated matter. Now if the heat is produced by condensation the whole body would be equally heated, and consequently no such partial separation would take place. Also the formation of a nucleus is difficult of explanation on such a theory, for although the *temperature* of the nucleus may be greater, the *actual heat* in the solar atmosphere must be greater. Secondly, as Siemens has pointed out, the heat being produced throughout the mass must reach the surface by conduction and convection. But we know of no substance capable of conducting the immense amount of heat which we find being radiated.

The Regenerative Theory.

This theory, which I have so named because of its most characteristic feature, is at present literally and absolutely in its infancy, It first saw the light in March, 1882, having been proposed in a paper entitled the "Conservation of Solar Energy," read before the Royal Society of London by the late Sir C. W. Siemens, F.R.S., the President of the British Association for 1882-83. It essentially differs from all the other theories in that it supposes the action of the Sun, in sending out light and heat, to be "capable of prolonging solar energy to the remotest future."* But if it is to last for such a time, it is a physical necessity that very little of anything should be used up or expended. Accordingly the action is maintained by the energy being conserved and protected from loss. This is accomplished by supposing reciprocal actions to go on using only the same materials, but under different conditions. The different conditions are those which obtain in or near the Sun, and those of interplanetary space. In the one case we have intense heat, and in the other equally intense cold; and I may here remark that it would be impossible to conceive of matter being placed in positions which afford conditions possessing greater contrast. Matter is supposed to be subjected, at different times, to these different conditions, and its behaviour under such conditions produces in the one case the heat and light of the sun, and in the other the materials necessary for maintaining this heat and light. Without further preface we will state Dr. Siemens's theory in as nearly as possible his own words.

After briefly stating the various theories, and offering certain objections to them, he says—"The true solution of the problem will be furnished by a theory, according to which the radiant energy which is now supposed to be dissipated into space, and irrecoverably lost to our solar system, could be arrested and brought back in another form to the Sun itself, there to continue the work of solar radiation." After this preliminary assertion he proceeds to state the fundamental assumption that all space is filled with highly rarefied gaseous bodies, including hydrogen, oxygen, nitrogen,

* These are the concluding words of the first paper on the subject which was communicated to the Royal Society. In a letter to the present writer, however, Dr. Siemens states that he does not mean by this that his theory provides anything in the way of perpetual motion, but only that he considers it "capable of continuing solar radiation to a very remote future."

carbon compounds, &c. The planetary bodies scattered in such an atmosphere would attract to themselves atmospheres varying in density according to the varying density of the planet. But this attraction would be to a certain extent selective, and consequently such atmospheres would consist of the heavier, and therefore less diffusible, gases, while the lighter would remain in space. In space, therefore, there would be a vast preponderance of hydrogen and the lighter hydrocarbons. But, again, the planetary system as a whole will attract the rarefied gases existing in stellar space; thus we shall have existing in space what may be called three classes of atmospheres,—inter-stellar, inter-planetary, and planetary. Each of these will vary in density, the first according to the distances of the stars, the second according to the mass of the particular system as a whole, the third according to the mass of the attracting planet. In support of this view the molecular theory of gases is brought in,—the evidence afforded by the analyses of gases occluded by meteorolites which have fallen upon the Earth, and the teachings of spectrum analysis. Each of these is in itself a perfectly sound and practically unanswerable argument in favour of the existence of a universal atmosphere.

In regard to the idea that if such atmospheres did exist the central body of each system would attract to itself the heavier gases, whereas the revelations of spectrum analysis show a prevalence of hydrogen, Dr. Siemens remarks that it can be shown that at such a temperature as the Sun possesses no carbon dioxide or carbon monoxide could exist, and in fact supposes, with Lockyer, that the metalloids can also have no existence. But he says that outside the photosphere there must be regions where these gases would accumulate "were it not for a certain counterbalancing action." This counterbalancing action is provided for by the high rotative velocity of the Sun, which is equal to about 1·25 miles a second at the Sun's equator, or nearly 4½ times that of the Earth. Such a movement must cause an equatorial rise of the solar atmosphere. La Place has, however, calculated that owing to this cause the height of the solar equatorial atmosphere could not possibly exceed 9-20ths of the distance of Mercury. His calculation is, however, vitiated by his assumption of the emptiness of stellar space. If we suppose this action to go on in a medium, then a fan-like effect is exercised upon that medium, resulting in a movement outwards at the Equator and a drawing in towards the Poles. The Sun therefore, upon this hypothesis, is supposed to have around his Equator a

disc of matter rapidly leaving him, and at the Poles matter approaching him. In this way, Dr. Siemens says, enormous quantities of "hydrogen, hydrocarbons, and oxygen are supposed to be drawn towards the polar surfaces of the Sun." "During their gradual approach they will pass from their condition of extreme attenuation and extreme cold to that of compression, accompanied with rise of temperature, until on approaching the photosphere they burst into flame, giving rise to a great development of heat, and a temperature commensurate with their point of dissociation at the solar density. The result of their combustion will be aqueous vapour and carbonic anhydride or oxide, according to the sufficiency or insufficiency of oxygen present." These products of combustion will come under the influence of centrifugal force, and move towards the Equator, where they will be projected into space. As they recede from the Sun they gradually lose their heat, and become more and more rarefied, until they obtain the extreme state of rarefaction which they possess in inter-planetary space. Here it is supposed the inverse action to that which occurs in the Sun takes place. The now highly rarefied aqueous vapour and carbonic anhydride absorb some of the radiations which the Sun is constantly pouring out, and it is supposed that at the extremely low pressure to which they are subjected they are dissociated, oxygen, hydrogen, and hydrocarbons being produced. These are in turn again drawn in to the polar surfaces by the fan-like action produced by the solar rotation. Thus we see that a continuous circulation of matter occurs, the same element alternately forming a portion of the coldest portion of inter-planetary space, and the hottest portion of the central luminary.

Such in outline are the chief points of this latest theory of solar action. There are some other secondary points which are rendered necessary in consequence of the known constitution of the Sun. For example, we know that the solar atmosphere contains large quantities of the vapour of certain metallic bodies. These are supposed to constitute an inner atmospheric shell which is not affected, in consequence of their density, by the centrifugal force caused by rotation. This force, in fact, only affects the lighter materials, chiefly hydrogen constituting the circulating atmosphere. At the surface of contact between the two, however, intermixture induced by friction may sometimes occur, "giving rise to those vortices and explosive effects which are revealed to us by the telescope. . . . Some of the denser vapours would probably get intermixed and carried

away mechanically by the lighter gases, and give rise to that cosmic dust which is observed to fall upon our Earth in not inappreciable quantities."

Then, again, solar observation has revealed to us the undoubted fact that the quantity of solar heat varies from time to time, and that the condition of the photosphere, as indicated to us by the sun-spots, also varies. These are supposed to be accounted for by the circumstance that, as the whole solar system is moving through space with the velocity of 150,000,000 of miles annually, "it appears possible that the condition of the gaseous fuel supplying the Sun may vary according to its state of previous decomposition, in which other heavenly bodies may have taken part."

Since its first publication this theory has been subjected to a considerable amount of criticism. Some of this may be considered as favourable, while some is decidedly hostile. Most writers, however, agree with the theory on some points and disagree on others. Undoubtedly, if we accept all its conditions, we shall have to considerably modify some of our ideas of physical actions. Thus, for example, there is the question of what is known as dissociation, or the breaking up of chemical compounds by the influence of physical agents, such as heat, &c. Now it is almost an axiom in chemistry that the general effect of heat upon a compound is to break it up into simpler and chemically less complex substances, while the abstraction of heat is usually considered to bring about the inverse change. But in the theory it will be noticed that the breaking up of the compounds of carbon and oxygen and hydrogen occurs far out in space where the temperature is a very low one, and the re-combination takes place nearer to the Sun, and at a place where the temperature is much higher. But, as Dr. Siemens has pointed out, there are two things to be considered when speaking of dissociation, *viz.*, temperature and pressure; and he supposes that at a very low pressure, such as exists in space, these gases may be broken up by the absorption of some of the radiant energy from the Sun, although their temperature may remain very low.

The idea of a universal atmosphere, which is necessary for the purposes of this theory, although never prominently stated in our standard scientific works, is yet a very old one, dating from the time of Newton, who first made the assumption. It has been accepted since by many eminent and thoughtful writers upon the subject, including Grove, Humboldt, Zoellner, and Mattieu Williams, who have brought forward other considerations which strongly support

their assumption. Moreover, the constitution of such an atmosphere would be similar to that required by the theory.

For the criticisms which have been given and Dr. Siemens's replies I must refer the scientific reader to a work published by the latter gentleman, entitled the "Conservation of Solar Energy," and also to the pages of the "Philosophical Magazine." An exhaustive, or even a cursory, notice of these is beyond the scope of the present article.

The thanks of scientific men generally are, however, due to Sir W. Siemens for bringing prominently forward and formulating so ingenious a theory; their attitude with regard to it is one of waiting for further experimental evidence, and this evidence the lamented death of its illustrious author will probably delay.

II. A NEW THEORY OF THE TIDES.

By Robert Bell.

THIS article is intended to show that, although the moon is the chief factor in producing the tides, it is done by a different process than by attraction.

As an illustration, place a parcel of goods that is wrapt in paper on a table, and then push the parcel from you. The first thing that takes place in this last act is, that you make an impression on and disturb the envelope. Now this is exactly what takes place when the Moon, by means of her radiations, is giving the Earth a push.

Owing to the extreme susceptibility to pressure of the envelope that surrounds the solid portion of the Earth,—*i.e.*, the atmosphere,—a part of it is forced laterally in every direction, until it reaches that part of the Earth's sphere at the greatest point of elongation from the Moon.

There is now a greater quantity of atmospheric matter pressing on the water at this point than under the Moon, or at the opposite side to the Moon. The water yielding to

the pressure will be depressed at this point, and correspondingly raised under the Moon and at the opposite to the Moon. But the tide on the side nearest the Moon, all other conditions being equal, should be a little higher than the tide on the opposite, because, although the pressure will be equal at the place above indicated, the resistance at the other parts will not be equal, since a portion of the atmosphere on the side next the Moon has been forced away, while that on the other side retains its normal condition.

But why is it that the Moon's radiations do not force the atmospheric wave far enough around the sphere to prevent the water from rising on the other side? There are two reasons for this; and if the Earth always presented the same unchanging face to the Moon as the Moon does to the Earth, such a condition would partly exist. But the rays of the Moon are not felt on the other side, particularly so on account of the Moon's rays diverging as they pass the Earth; also, as the Moon apparently moves around the Earth, she is continually repelling the atmosphere on the one hand, and withdrawing her pressure from the other, thus permitting the atmospheric wave to return at this point sufficiently near to occupy its former relative position to the Moon, as it takes a little time for the Moon's rays to have their effect on the atmosphere, and also a little time for the atmospheric pressure to have its effect on the water. We can easily understand why it is that the tide is always behind the Moon. The atmospheric wave, above referred to, is the cause of the diurnal variations of the barometer; and if there were no local disturbance to the atmospheric wave, and none to the ocean wave, the barometer would be a perfect indication to the height of the tides,—*i.e.*, when it would be high tide it would be low barometer, and *vice versâ*.

Admitting the above theory of the tides to be sound, let us consider what effect it would have on the Moon. If the volume and density of the atmosphere and water of the Moon are in proportion to those on the Earth according to their relative mass, then in this case the radiant force of the Earth would force the whole atmosphere of the Moon to the other side, and if there is any water on the Moon it would necessarily be all on this side, and if there is no water on this side it follows that the Earth's radiant powers have forced the water also to the other side of the Moon, in which case there would be a tranquil sea on the other side, with neither tides nor storms to disturb its calm repose.

Stonewall, January 2, 1885.

III. BELL BUOYS, AND BUOY SIGNALLING.

By Rev. SAMUEL BARBER.

ANYONE who knows the history of the wrecks which have occurred on the Cumberland coast, especially between Seascale and Whitehaven, and thence to Maryport, must be impressed with the want of sufficient warning to vessels, at night, and in the case of fogs occurring. The use of a lightship by way of direction is obvious, but often when most needed these are invisible, and the only apparent alternative is a Sound Signal. The Bell Buoy at the entrance to the Mersey has long suggested an extension of this useful method of indicating position, but this has unfortunately been too little adopted by those who regulate matters on our coasts. The want of two or three such buoys near the rocks at prominent parts of the coast abovementioned has probably resulted in the loss of many vessels and of some human lives.

I therefore venture to draw attention, again, to this matter. There can be little doubt that mechanical science is equal to constructing and placing these useful signals in the positions indicated. The use of a lighthouse is one thing, that of a bell signal another. And although it is necessary that lightships be provided with fog-horns, and thus partially answer the purpose of a bell buoy, the expense of multiplying such ships will always preclude their doing duty for such buoys.

It may perhaps be objected that there would be a danger of confusion resulting from any large increase in the number of such bell-signals. My reply is that of course it is *possible* to needlessly multiply them, but the purpose here advocated is the indicating by sound-warnings the more dangerous points of rocks, sunken rocks, banks, and currents, especially wherever experience has shown that disaster is most likely to happen.

Now, in a fog, a single bell can give but little indication of the direction in which a vessel is moving. *Some* indication will indeed ensue from noting whether the sound increases in loudness or dies away, and to a ship approaching land this would be of great value; but the main use of a *single* bell would simply be to warn off from the point where it was placed.

In such places, however, as it is important to give a definite idea of direction, I may suggest that *two* bells placed some little distance apart—say from a quarter to half a mile—might, to a certain extent, do the work of lightships or lighthouses. A distinct variation of sound being given to each bell so placed, and the nature of each being noted on the published directions to mariners, position and direction may approximately be ascertained by noticing the relation which the sounds bear to one another, and the manner in which each tone increases or diminishes in intensity. The direction N. S. or E. W., &c., of a line from one to another should of course be known to captains.

Wherever advisable, and especially near sea-ports, it would be a valuable addition to buoys, so placed, if they were provided with an additional bell worked by an electric current, and communicating with the nearest sea-port by a cable. Thus, for example, matters relating to anchorage and docking, or the extent and position of fog, &c., might be made known to a vessel lying off (when the state of the sea allowed it) in such positions as are beyond the range of ordinary signalling.

It would be interesting to have a list of such buoys as are placed in deep water, with particulars as to mooring, depth of sea, and special features in construction.

The question arises—Have cables, stretched from one coast to another, or from the mainland to islands, been sufficiently utilised as a base from which to suspend the buoys?

I will conclude these remarks with another question, for electricians. Could a buoy connected with the land by a cable, and having a smaller float attached with a chain, be so constructed as to become a medium of communication between shore and vessels afloat? It would not be difficult for a ship to pick up such a chain and float, and to join wires. The larger steamers already carry electrical apparatus in many instances. It would appear that the experience of Atlantic cable-laying has gone a long way towards solving this question, and the remainder seems to be a problem for mechanics rather than electricians.

Seascale, Cumberland.

IV. PSYCHOGRAPHY.

By R. M. N.

THE remarkable phenomenon known as Psychography is exciting very general attention. The question of its genuineness, and, if genuine, of its nature, is being acrimoniously discussed. One distinguished *savant*, taking unwittingly a leaf out of the book of the Bestiarians, wishes to suppress research in this direction by the blundering arm of the Law. Even the *ultima ratio stultorum*, the formal appeal to Plutus, has been duly invoked. Surely therefore it is time that these alleged facts should be studied in the same calm, cold manner, and with the same indifference as to possible results, as are customary on the announcement of the discovery of a new planet or a new metal.

A word as to my point of view. I am no "Spiritualist." Certain of the doctrines of Spiritualism, as I apprehend them, would be to me highly unwelcome; but to refuse the investigation of novel or unexplained phenomena on such grounds is assuredly unworthy of a man of Science. We cannot dispose of truths by the simple process of shutting our eyes and denouncing their discoverers as "skunks."

The facts of so-called "Psychography" are simplicity itself, and will need here merely the barest recapitulation. Two persons meet in any ordinary room: one of them, the so-called medium, sits quietly in a chair, generally near a table of ordinary construction. The other person, whom I will call the investigator, takes two clean slates, binds them firmly together with waxed thread, having left between them a fragment of slate-pencil or of red chalk, and lays them on the table. The medium places his hand upon them, and in a short time, supposing the experiment successful, a sound like that of writing is heard. On untying the slates one of their inner surfaces, or sometimes both, is found covered with writing, whilst the slate-pencil or other material is found worn down as if it had been used.

The features of the experiment have been much modified on different occasions. The slates used are sometimes taken by the observer from a heap kept for the purpose by the medium, and before being used are carefully cleaned by the observer with a sponge and water, and rubbed dry with a cloth. Not unfrequently the observer brings with him a

pair of new slates which he has bought on his way to the medium's house. In some cases a double folding-slate has been used, secured by a lock.

The position in which the slates are laid after being secured together has also greatly varied. Sometimes they are laid *on* the table, the medium touching them with one hand. Sometimes the medium holds them against the under surface of the table with one hand, whilst with the other he holds the hand of the spectator. Again, the spectator has held them upon his own head with one hand, whilst with the other he clasps that of the medium. Or they may be laid upon the table, and never touched by the medium at all. All these experiments, it is well to remember, are performed in full, open daylight.

The nature of the table used, and of the chair in which the medium sits, is a matter of indifference. Both have been carefully examined without disclosing any mechanism or concealed appliances whatever. Other tables and chairs have also been substituted; but the phenomena are unaffected.

Something must also be said concerning the subject-matter of the writing. Very frequently the observer writes some question upon the slates before closing them up, and receives a definite answer,—occasionally touching matters known to no living person but himself, and of which the medium cannot be supposed to have any knowledge. Such answers may even be given in languages with which the medium is unacquainted. Nor must it be forgotten that the observer is sometimes asked, after putting both a bit of pencil and a piece of red chalk between the slates, with which shall the expected writing be produced? And the result comes out accordingly.

It is not, I think, necessary to go more closely into the details of psychographic experiments, since they may be found given with considerable minuteness in various works and journals. But the question is, How are these recorded phenomena to be explained?

The first attempted solution is, if nothing else, remarkable for its sweeping character and for its simplicity. The spectators, we are told, are all conscious and intentional liars. Such an explanation scarcely admits of discussion. To most minds it will be utterly inconceivable that a number of persons, of different ages, nationalities, prepossessions, habits, and thought, should agree in forging a falsehood from which they could reap no manner of advantage. Most minds will conclude that were such the case some one

witness, at least, would have come forward to expose the fraud—an exposure which, in not a few quarters, would be exceedingly welcome. How, then, on the hypothesis of falsehood, do Spiritualists contrive to seal the lips of each succeeding spectator?

The next hypothesis is that the spectators, though not intentional deceivers, are self-deceived, and fancy that they see occurrences which never took place. Or they are pronounced to be incompetent, untrained observers. A moment's reflection will show that this supposition cannot hold good. In the first place must be noted the extreme simplicity of the phenomena. There is nothing to excite any passion or emotion; nothing to engage ear and eye, and thus draw off the attention of those present from what is being done, or rather from the manner in which it is effected. There is nothing that requires the trained observer or the scientific specialist. Were it a question turning on delicate spectroscopic or microscopic observations I should not for a moment accept the evidence of a non-specialist, however highly educated, intelligent, and upright. But this is not the case: any sane man of common sense and fair moral character can decide as well as Professor E. Ray Lankester whether the slates used were clean before being tied together,—whether the medium had, or had not, the opportunity of tampering with them,—and whether, when untied, they were found covered with written matter. I repeat it that, to my apprehension, the most illustrious man of Science would have no advantage in making such observations.

But I may be told that it is all clever jugglery. Jugglers can certainly do very surprising things, and they are in these days a prosperous and influential class, whose honour and reputation the Law appraises at a high figure. But I may at least, without fear of an action for libel, assert that their power has its limits.

No juggler has as yet reproduced the phenomena of "Psychography" as above described, and under test conditions. If Maskelyne and Cooke will, like Eglinton, sit down at an ordinary table, and, without apparatus of any kind, produce intelligible writing between two locked slates, which never pass into their hands at all, and which they thus have no opportunity of manipulating, we may then with a show of reason refer this matter to jugglery.

But let us examine this part of the subject a little more closely. How can jugglery be conceived as possibly producing the results described? It may be said that the writing pre-exists on the slates before they are tied together,

and becomes visible in consequence of the escape of — a something. This hypothesis is not easily reconciled with the circumstance that, even when the slates are the property of the medium, they are selected by the observer at haphazard from a heap, and are well cleaned and carefully examined by him before being tied together. But it is put completely out of court by the fact that the slates are often brought by the intending observer, and have never even been seen by the medium or by any possible confederate.

The next supposition is that the medium unties or unfastens the slates after they have been fixed together, executes the writing, and fastens them up again as before. We will take the case most favourable for this view,—that, namely, where the medium holds the slates against the underside of the table with one hand, his other hand and all the rest of his person being full in the view of those present. Are we to admit that with that one hand he unties the slates, supports them and the strings or tapes, performs the writing, and ties the slates together again? If so, great is our faith. It may be urged that there are supports beneath the table, by which the slates, string, &c., are upheld while the medium is writing. I reply that the table has been examined, and that no such contrivances are to be found. But how about those cases where the slates lie all the time open to view, upon the table or on the head of the observer, the medium not touching them at all? Such are crucial instances which completely overthrow this unfastening and writing supposition.

I have also heard it insinuated that the slates upon which the writing is found are not the same pair which have been formally prepared, these latter having been dexterously conveyed away and others substituted. This hypothesis is negatived by the cases where the slates remain in view, and are never handled by the medium. It also fails to account for the fact that slates brought by inquirers, and marked privately without the knowledge of the medium, are expressly found not to have been changed.

"The effects are due to electricity or something,"—the something being, I will charitably suppose, some other possibly as yet unknown form of energy. That electricity can produce strange effects I shall not question. Nor shall I dispute that there may be forms of energy still more wonderful. But the table and the seat of the medium contain no hidden batteries, no secret conductors. They may, as I have already pointed out, be exchanged for others. They may also be removed to any other part of the room, or to

another room,—a step by which any physical arrangements would necessarily be frustrated. Nor has any spectator detected the presence of electric or magnetic currents on or near the table.

We may go further: electricity, magnetism are not intelligences. By their means it is indeed possible to transmit messages, questions, or answers from one place to another, and to reproduce them in speech or in writing; but there must be an intelligence at the other end of the line. It is utterly inconceivable that electricity or any physical force should of itself combine letters into words, and words into intelligible sentences, conveying often a precise and accurate reply to a question put. It is known that an electric commotion passing over a telegraphic system will sometimes set the instruments at work; but the messages thus sent are mere random combinations of letters, which never—save by rare chance—form even a word, and never certainly an intelligible combination of words. Should such a thing ever happen every experienced telegraph operator would feel sure that some trick had been played, and that the message was not and could not be the outcome of an electric storm.

The writing, it seems to me, must indubitably be produced by some intelligence. But what intelligence? Not by a man; for, in addition to the fact that the crumb of pencil or chalk is generally too small to be grasped by human fingers, we have invariably the testimony that no person has or could have in any way interfered with the slates. Surely we are thus driven from post to pillar until we have but one alternative remaining,— the assumption that there must exist around us intelligences invisible and capable of interfering with the course of events, with what we are accustomed to call the order of Nature. What these intelligences are, what is the extent of their power, and under what conditions it is exerted, I am utterly ignorant. They may be, as the Spiritualists hold, the "spirits" of departed human beings; or they may be the "spooks" or "shells" of the Theosophists, the "elemental spirits" of the Rosicrucians, or the fiends and familiars of mediæval sorcery. To which of these classes the agents in question belong is still an unsolved problem. The Spiritualists allege that the minute acquaintance which these intelligences show with family secrets, with private conversations formerly held between the investigator and the deceased friend, prove their identity with such friends. But it is replied by other persons, believers all the same in the reality of Psychography and of

kindred phenomena, that if we are surrounded by invisible intelligences they may know our past careers, our actions, our words, perhaps even our thoughts, and may thus easily assume the part of some friend whom we have lost. It is even conceivable that these invisible intelligences may not be spirits at all, but strictly material beings, capable of acting in 4- or 5-dimensional space, as expounded in the last issue of the "Journal of Science," and which under all ordinary circumstances escape our perceptions.

Hence it seems to me premature to pronounce these and similar manifestations a refutation of Materialism. It is probably still more premature to infer from such phenomena the continued existence of man after what is ordinarily called death. On these points Psychography does not appear to give any definitive assurance.

But the conclusion seems to me unavoidable that if unseen beings, be they spiritual or material,—whatever these terms may mean,—can interfere with the cause of Nature, we have no longer any assurance that like causes will be followed by like effects.

To give an instance: every man who knows that fuel has been laid in a stove, and who some hours afterwards finds it blazing, will conclude—perhaps I must say "would have concluded" until lately—that some human being had set it on fire. Yet we find it recorded in "Light" that a certain family were regularly accustomed, on rising in the morning, to find their kitchen fire had been kindled by some invisible being. Now if "spirits," or 4-dimensional beings, can thus interfere, what confidence can we have in the results which we obtain in our chemical and physical laboratories? In fact it is hard to say what basis remains on which Science can be built.

I read, in a recent article in the "Journal of Science," how an eminent chemist points out the necessity of performing toxicological investigations in a laboratory to which no one but the operator can have access, lest some interference, intentional or accidental, might take place. But if invisible agencies can interfere, how are they to be excluded?

Bearing in mind these considerations, Spiritualists might well speak in a milder tone of the reluctance of scientific men to accept their results. Of course an unpleasant truth is not the less true if we close our eyes to its evidences and to its existence. But what if the activity of the last forty years has made possible what before was impossible? How if the little "tap, tap" of Spiritualism has not merely

"shattered the marble image of Materialism," but broken down a partition-wall which barred out invisible agencies from interference in our world? In that case it strikes me that the refutation of Materialism has cost us far too dear.

V. THE LIMITS OF SANITARY REFORM.

HYGIENE, or as we Britons prefer to call it "Sanitary Reform," is of far wider scope than we commonly suppose. If fairly studied it will be seen to involve something much more than a "policy of sewage,"—something weightier than the appointment of costly commissions, Royal or Parliamentary, the purification of rivers, and the suppression of a few desultory nuisances. It includes war against every custom, every institution which tends to debilitate our population, whether it be of a direct or an indirect nature. Taking its stand on the old axiom "Salus populi suprema est lex," it claims precedence alike over the dogmas of political economy and over the dictates of political party. "Direct or indirect" we say. The man who shoots down or stabs his neighbour in the street does ill; but the man who intentionally, and as a matter of business, gradually undermines the health of his neighbour, does still worse. For the man suddenly and directly murdered does not, on that account, necessarily leave an enfeebled, debilitated posterity; but the man who (say) in the third decade of his life succumbs to unsanitary influences, very often leaves to his children an inheritance of what is absurdly called "delicacy." Hence the effects of indirect murder are progressively cumulative,—a continual supply of the "unfittest" being thus provided that they may be trodden down in the struggle for existence.

We have made war, and with a certain measure of success, against typhoid fever, dysentery, scarlatina, cholera, and other diseases comparable to the direct homicide. But what have we done against pulmonary consumption, scrofula, heart and brain diseases, Bright's disease,—in short against all those maladies which, like the indirect murderer, slowly prostrate their victim, giving him the opportunity to procreate

an offspring who inherit either the actual specific diseases of their parent or else a general debility which lays them open to every form of sickness? What have we done towards the extirpation of such diseases? Nay, rather what have we done to promote them? Have we not taken a variety of steps to encourage "worry,"—that is, work under the pressure of anxiety? This most debilitating condition lies at the very root of our system of competitive examinations. It is a known fact that on medical investigation a considerable proportion of the *successful* candidates for the India Civil Service have been found to be suffering from albuminuria, the result of the recent strain upon the nervous system. Of course accurate statistics of the number of candidates, successful and unsuccessful, physically injured by preparing for "an open examination" cannot be obtained. Government would assuredly discourage and thwart any attempts in this direction. Could the anti-hygienic results of this scheme be fully laid before the nation they would almost unanimously decide that some more excellent way of selecting candidates for appointments must be adopted.

But we have no time to enlarge upon this part of the subject. Public elementary education has been also cleverly converted into a machine for the promotion of general debility. The disclosures recently brought forward by Dr. Crichton Browne are still fresh in the public mind. No less fresh are the attempts made by officials to keep their own eyes and those of the nation closed against these startling revelations, and the somewhat lame and impotent conclusions reached after due consideration. The official mind refuses, above all things, to see that the root of "over pressure in education" is the Satanic device of "payment by [pseudo-] results." But on this subject also we cannot stay to enlarge.

It has been asserted that the Englishman of to-day is not inferior, physically, to his forefathers of fifty or a hundred years ago. We question whether this conclusion rests upon a sufficiently broad basis. But to avoid a discussion for which conclusive data are wanting let us admit that the country gentleman, farmer, farm-labourer, or navvy of this day is as healthy and vigorous as was respectively the country gentleman or farmer, &c., of the year 1830, and in like manner that the town-bred workman or shop-assistant of 1880 is physically equal to his predecessors of half a century ago.

Even then there remains the grave fact that a far greater proportion of the nation is placed under less favourable

circumstances as regards health than was the case at the beginning of the century. We must admit this fact, unless we are prepared to deny the progressive depopulation of the open country and the concentration of the people in the great cities. This means a relative increase of men doomed to occupations either sedentary, or, if involving physical activity, still exercised in the absence of a sufficiency of light and fresh air.

It is only from this point of view that we can realise the true meaning of the present agricultural depression. Every thousand acres of land thrown out of cultivation, or laid down to permanent pasture, means so many men and women driven from the free air of the country to the slums of London, Liverpool, Glasgow, and the like. Perhaps one of the noblest tasks which a true statesman could undertake would be to devise a remedy for this desertion of the open country. But our professional politicians of both parties look on in "sick stupidity" while the deadly game proceeds.

Mr. James Cantlie, in a lecture recently delivered at the Parkes Museum, has uttered a sound of warning. He took for his subject the "Degeneration amongst Londoners." Now if we bear in mind that London contains about one-eighth part of the population of Britain, and that our other large towns—where the vital conditions are essentially similar—raise the proportion to one-sixth, this degeneration is indeed a hand-writing on the wall.

Mr. Cantlie is reported to have described London as "an ozoneless region, where exercise in fresh air is impossible to obtain, and where the sun's rays are deprived of all health-giving power." The supposed effects of ozone, or of its absence, we are not about to discuss, since its existence in the atmosphere has not been proved with sufficient precision. But the difficulty of obtaining exercise in, or even mere access to, fresh air we fully admit. Nor can we deny that the sun's rays, even in the suburbs, differ both in quantity and quality from those poured out upon the open fields.

The lecturer defines the normal Londoner, whose degeneracy he discusses, as one whose parents were born in London and spent their days there, and who himself has had the same unhappy destiny. It is, of course, obvious that numbers of the inhabitants of London do not fall within this category. Leaving out of consideration the higher classes, on the one hand, and the vagrant nomadic population on the other, who spend a part of each year only in the great city, we have further to exclude soldiers and sailors, who may be

residing in London one year and the next may be at the antipodes. But if we look at the permanently domiciled civil population we shall be surprised to find how many of them have been born and brought up in country districts, and how many more are the offspring of country-bred parents. This is, in itself, a striking fact. It proves that the true-bred Londoner, the cockney of the cockneys, must rapidly die out. This fact is brought prominently forward by the lecturer. He maintains that it is "well nigh impossible to find a third, and absolutely impossible to find a fourth, generation of pure Londoners, the progeny ceasing partly from moral and partly from physical decline and inability of continuance." The pure Londoner of the third generation whom he had been able, after much search and inquiry, to get hold of, was "a type of physical decline, involving diminutive stature, narrow chest, deformity of jaws, miserable appearance, scrofulous diseases, and small head. Pure Londoners are seldom to be found in workhouses, as they die young. They are able to 'light porter,' sell papers, and earn a livelihood by some such shiftless means."

The picture thus drawn of the thorough-bred Londoner applies fairly enough to the aborigines of other great cities, at home and abroad. The Parisian *ouvrier*, we are told, never becomes a grandfather. In Berlin the proportion of young men declared unfit for military service is most signally higher than in the small towns and villages of the German empire.

Mr. Cantlie holds that but one way exists for avoiding the present ills,—*i.e.*, "securing for the young such an amount of beneficial sojourn in a pure atmosphere as shall enable the bodily functions to be performed under circumstances the most favourable to perfect physical development." Here we must presume to differ from him. As the degeneracy of our town-population is due to the combined action of several factors, so a variety of remedial measures are not merely possible, but necessary.

One of these will consist in the introduction of sanitary inspection into regions where it has not hitherto been attempted. It has been found necessary in factories of various kinds, not only for the hours of work to be regulated by law, but for a variety of conditions to be enforced which are considered essential for the health of those employed. But establishments where nothing is manufactured, and where merely sale is carried on, are outside the provisions of the law. Yet some of these establishments are conducted

without the slightest regard to health, and exert, in consequence, a most prejudicial effect. State interference is here, in fact, much more necessary than in factories, since in the latter the hands go home at night, if not also during the dinner-hour, whilst in large selling-shops—wholesale and retail—a very large proportion live and sleep on the premises. We have made it our business to collect information concerning the sanitary condition of such concerns, not omitting the monopolist drapers, who are now so common, and we regret to say so prosperous, in all quarters of London. We cannot, of course, name the establishments to which we refer, as, independently of the score or more of actions for libel which would be our reward, our informants would reap immediate dismissal, and would be boycotted throughout the trade.

In these shops phthisis and scrofula run riot, the former perhaps more among girls, and the latter among young men. Of this any medical man may convince himself with little trouble; the seamed and knotted necks of the sufferers tell their tale too plainly. No less striking are the narrow, hollow chests, the worn, weary expression of the features, and the sudden flush of the cheeks on any exertion. Now it may be urged that the hands are phthisical or scrofulous, as the case may be, when they enter these establishments. This we deny: many of them are enticed up from the country by delusive advertisements; but the conditions under which they are placed are admirably adapted to foster any tendency to disease. Deficiency—or rather absence—of ventilation, and an atmosphere charged with the products of the combustion of gas,—which in these shops is burnt in prodigious quantities,—are prominent elements of evil. The sleeping apartments are small, and, especially as far as girls are concerned, two have to sleep in one bed, the one perhaps already consumptive. Then there is the absence of open-air exercise. From morning to night the whole time, substantially, is spent in a standing position, which fatigues much more than does a brisk walk.

Some time ago an outcry was raised touching the cruelty of thus compelling girls to stand for the entire day, and not permitting them to sit down even in the entire absence of customers. Some shopkeepers were, we believe, shamed into allowing their shop-girls to sit down when disengaged; but this trifling amendment soon melted away. We have heard of cases where girls have been savagely reproached for leaning on the counter when at liberty. We know even of an instance where the head of a certain firm removed

with his own hands, from one of the "departments," a chair which had been placed there for the use of customers, lest the assistants should sit upon it. Pulmonary consumption and scrofula are not the only diseases which flourish in these establishments. From the information which reaches us we believe that acute rheumatism — commonly known as rheumatic fever—is very rife. Hysterical affections are also frequent among the female hands, due evidently to the generally depressing influences which surround them, and in no small extent to the bullying language of the "shop-walkers."

The hours of work are far longer than the outside world is aware. The hands are often kept busy for some time at night after the doors are closed to the public. Indeed, when preparations are being made for one of those farces duly advertised as "our annual sale," "our clearance sale of winter goods," &c., it is nothing uncommon for some, at least, of the *employés* to be kept hard at work till 2 a.m., or even beyond,—an addition to the day's work for which no extra consideration is given, such as, *e.g.*, the carpenter or the bricklayer enjoys for overtime. Stock-taking is another occasion on which work is prolonged *ad libitum*.

As regards what are euphemistically known as the "sanitary arrangements," they are too often grossly inadequate to the number of persons on the premises, and generally speaking in bad order. Sometimes an unpleasant odour even reaches parts of the premises to which customers have access.

During the time of the "sales" above referred to it has even happened that these conveniences have been locked up for a considerable part of the day, lest the employer's precious time should suffer. What influence this must have on the health of the hands needs surely no expounding. It is likewise customary for the doors leading to the sleeping apartments to be locked all day, an arrangement which, as far as the female hands are concerned, is under certain circumstances exceedingly prejudicial to health.

The exposure to cold is, in times of fog, frost, keen winds, or damp, exceedingly hurtful, especially as the victims cannot counteract its effects by brisk exercise. In some of these establishments the girls take breakfast in a cold room, go down to their work in shops which are not provided with any warming appliances, go to dinner in a cold dining-room, and have then the privilege of spending the residue of their dinner hour in a fireless sitting-room. Not until the day's business is over, say 8 p.m., is a fire lighted in this room.

Thus, however severe the weather, these ill-fated girls never have the opportunity of warming themselves until between eight and nine in the evening. That in some of these establishments the food is of doubtful quality, ill-cooked, and little qualified to stimulate an appetite not kept in tone by out-door exercise, is another count in the indictment.

These anti-hygienic features are not to be met with to an equal extent in all the sale-shops and warehouses where large numbers of hands live and sleep "in." But our information is mainly derived from establishments which rank among the best-conducted of their class.

Another point, which perhaps scarcely comes under the head of Hygiene, is that the hands have rarely an opportunity of taking air and exercise until about nine in the evening. How ill-adapted the streets of London are for this purpose, in the case of young women, does not need to be demonstrated. It will thus be seen that we have here powerful, efficient causes of physical degeneracy and of positive disease affecting a very considerable proportion of the population. Mr. Cantlie's proposal leaves this source of evil absolutely untouched.

It may be forgotten that in the rise of the factory-system the scheme of "living in," in so-called "bothies," was tried. Their necessary suppression gives a precedent for similar measures elsewhere.

Further information concerning the hygienic shortcomings of shops and warehouses, as well as of failures in health consequent upon "preparing" for examinations, is earnestly solicited, under the strictest confidence.

VI. THE SUGAR INDUSTRY.

By Robert Galloway, M.R.I.A.

WHEN I wrote the article on the extraction of sugar from the juice of the cane and the juice of the beet-root which appeared in the September number of the "Journal of Science," I had no personal knowledge of the condition of the sugar manufacture in the Island of

Mauritius, nor had I met anyone who was practically acquainted with the industry in that Colony. Since then I have become acquainted with a gentleman who is the proprietor of a large sugar estate in that Island, and who has himself lived there, and is, therefore, will acquainted with the sugar manufacture as it is carried on in that Colony. The information he gave me coincides with what I had already stated with regard to our West Indian Sugar Colonies. In the Mauritius they extract, he informed me, only seven out of every twenty parts of the sugar which is present in the cane juice. This great loss of nearly two-thirds the amount is not attributable to the non-employment of the best machinery; my acquaintance, for example, has the best modern machinery on his estate, and it has cost him £30,000. It is therefore evident that on this estate as on those I visited in the West Indies, the loss in sugar arises chiefly from the imperfect purification of the juice. My acquaintance said to me "You are perfectly correct in stating that the loss sustained is owing to the want of skill and intelligence." He said, "I am almost surprised that we extract even as much as we do, for neither the proprietors, nor the managers, nor anyone connected with the industry know anything about the manufacture beyond mere rule-of-thumb." "If we could only," he said, "obtain ten parts instead of seven, of the twenty which exists in the juice, it would render us prosperous in spite of the importation into England of the bounty fed continental beet-sugar." As an instance of the want of skill and intelligence, native boys, after a fortnight's training, are given the sole charge of the vacuum pan. To illustrate the loss that may be sustained from intelligence not conducting this one operation alone, I will mention a case I became acquainted with some time ago; a change in the method of purifying the sugar solutions having been accomplished in a factory whereby the saccharine solution was rendered purer caused a serious money loss to the owner, and the process was credited with it, whereas it was due to the rule-of-thumb man who boiled the sugar solutions; he could not manage these purer sugar solutions in the pan—crystallisation taking place more rapidly than was the case with the impurer solutions he had been accustomed to boil—and he, as is usual with such men, concealed his want of skill from his employer by tricks and artifices; the money loss sustained being attributed to the process.

I inquired of the Mauritius proprietor how they disposed of their molasses. He said formerly distillers in the Island used to buy it and convert it by fermentation into an inferior

rum which they exported to the Island of Madagascar, but since the French commenced hostilities there, that market has been closed to this and other importations. This planter had therefore tried exporting the molasses to England, but what it sold for here did not pay the cost of carriage. He had, therefore, directed his manager to employ it in future as manure.

I am glad to see by "The Sugar Cane" for this month (February), that the Committee of the Agricultural Society for Barbadoes have drawn up a series of resolutions on the Central Factory System, and have sent a copy to the proprietors of the different estates on the island. The following is the first resolution:—

"That central factories are desirable as the most practical means of rendering the manufacture of sugar in this island profitable."

English investors need not, therefore, in future seek out such distant and hazardous places as the Argentine Republic, if they wish to invest their money in the sugar manufacture; they will doubtless soon have an abundant opportunity of investing their money in that industry in our own Colonies. Then, again, what a splendid opening this establishment of Central Sugar Factories in our colonies would have been for our young chemical engineers if we had established a sound system of Technical Education, instead of that most inefficient and miserable, but very costly system, established by the *Military* at South Kensington.

ANALYSES OF BOOKS.

Forty-five Years of Registration Statistics, proving Vaccination to be both Useless and Dangerous. By A. R. WALLACE, LL.D. London: E. W. Allen.

IN this little work Mr. Wallace attempts to prove, by official statistics, the four following propositions:—

1. "That during the forty-five years of the registration of deaths and their causes smallpox mortality has very slightly diminished, while an exceedingly severe smallpox epidemic occurred within the last twelve years of the period.
2. "That there is no evidence to show that the slight decrease of smallpox mortality is due to vaccination.
3. "That the severity of smallpox as a disease has not been mitigated by vaccination.
4. "That several inoculable diseases have increased to an alarming extent, coincidently with enforced vaccination."

It must be admitted by all observers that we are far, very far, from having got rid of smallpox, as at the introduction of vaccination it was promised and hoped. The disease still clings to us, in spite alike of vaccination and of sanitary reforms. But the question is, whether this failure is due to the inefficiency of the supposed safeguard or to its very frequent neglect? The figures here quoted show that, according to Dr. Seaton's evidence before a Parliamentary Committee in the year 1871, the average vaccinations were only 49·46 per cent of the births. So that about half the infants born escaped vaccination. This was of course after the introduction of the present law, which came into force in 1867. It may be asked, What is the present proportion? Judging from the curve showing "efficient vaccination," in the author's second diagram, a still larger number of infants now are unvaccinated.

The author declares that "there has not been any gradual extension of the practice of vaccination, but, so far as official records go, just the reverse." We are well aware that the relative numbers of infants vaccinated and unvaccinated do not show the proportion of the vaccinated population. Still it is evident that a very considerable part of the nation is unvaccinated, and the defenders of the practice are—as far as this part

of the argument goes—warranted in saying that vaccination has not yet received a fair trial.

This compels us, overstepping for the moment the second and third propositions, to turn to the fourth,—the increased prevalence of diseases which may be, and in certain cases actually have been, communicated by vaccination.

Among these rank syphilis, cancer, tabes mesenterica, pyæmia, and skin disease. In all these a steady increase must be admitted. Thus in the four years 1850 to 1854 the average death-rate in England from syphilis was thirty-seven per million of the living population; from 1875 to 1879 it had reached eighty-six; and from 1878 to 1880 eighty-four!—an increase of more than 100 per cent. But if vaccination is a main factor in the spread of syphilis, it is strange that an *increase* in the latter should coincide, as Mr. Wallace's curve and his quoted words alike show, with a *decrease* in vaccination. The same remark applies, of course, to the other inoculable diseases.

The statistical argument that smallpox has not been mitigated by vaccination seems to be decisively made out. The proportion of smallpox cases occurring is duly recorded. So also is the number of deaths. But on comparing these figures it is found that the proportion of deaths to cases is little lower now than it was before the introduction of vaccination. The most trustworthy returns available, from the years 1723, 1746 to 1763, and 1779, give a general average of 18·8 per cent.

In our day Mr. Marson's returns, 1836 to 1851, and the reports of the London, Homerton, Deptford, Fulham, and Dublin smallpox hospitals, from 1870 to 1880, give a general average of 18·5. This is surely a trifling gain if we remember that medical science has made great advances since 1779, and that the management of hospitals has been notably improved. Yet all this progress, with vaccination to boot, only scores the pitiful decrease of 0·3 per cent!

The strongest part of Mr. Wallace's case is drawn from military and naval statistics. All soldiers and sailors are vaccinated on joining the services, whether they have been previously vaccinated or not. Being a picked body of men, in the prime of life, they are healthier and stronger than the general average of the male population. They are placed under constant medical supervision, and enjoy ample food and fresh air. Yet the death-rate from smallpox in the army is 83 per million, and in the navy 157 per million. On the contrary, the smallpox death-rate among the adult male civil population, including the unvaccinated, the weakly, and the diseased, ranges in five of our large towns from 89 to 131 per million. Yet our soldiers and sailors have the advantage of passing some part of their term of service in the Tropics, where *smallpox* is less prevalent. Surely if re-vaccination were the safeguard which it has been considered, the army and navy ought to be exempt from smallpox. We find no

evidence to show whether vaccination from the calf gives better results than does the transfer of vaccine lymph from one human being to another. Perhaps statistics on this point are not procurable.

The greatest difficulty connected with the subject is to understand how, if Mr. Wallace is in the right, such a vast majority of medical men uphold the practice. The fees for vaccination are small, and if the profession were so much under the dominion of self-interest, as it is asserted by anti-vaccinationists, they would be reluctant to check the spread of a disease every case of which must bring them more emolument than a dozen vaccinations.

Nature's Hygiene. A Systematic Manual of Natural Hygiene, containing also an Account of the Chemistry and Hygiene of the Eucalyptus and the Pine. By C. T. KINGZETT, F.C.S. Second Edition. London: Baillière, Tindall, and Cox.

THIS work, since the appearance of its first edition, has been much enlarged, and indeed to some extent re-written. Its first part now forms a very complete manual of hygiene, whilst the second is devoted to the special consideration of the Pine and the Eucalyptus as sanitary agents. The title selected, "Nature's Hygiene," is significant, since it is the author's especial object to point out the existence and the *modus operandi* of natural means for the destruction, or at least repression, of zymotic disease.

In certain introductory chapters, containing chiefly matter with which our readers will be perfectly familiar, the author shows that the great natural disinfectant is hydrogen peroxide, —the occurrence of ozone in the atmosphere being by no means decisively established. Whatever processes, therefore, whether in the organic or the inorganic world, by which hydrogen peroxide is evolved, must of necessity contribute to sanitation.

From these generalities we pass on to consider the author's views on some of the great hygienic questions of the day. Mr. Kingzett regards the inorganic constituents of water as unobjectionable in drinking-water. This is a rightful protest against the Sensationalism which summed up carbonate of lime amidst the impurities which alarmed Londoners were said to be swallowing by hundreds of tons. But our author would agree that lead present in water renders it unfit for drinking-purposes, as

decidedly as can putrescent matter. And though the recommendations of the late Rivers' Pollution Commission, which

> "schleppen sich
> Wie eine ewige Krankheit fort,"

fix no bounds to the proportion in which magnesian salts may be poured into a river, their action is in the long run decidedly unsafe.

In discussing the condition of the Thames above London, Mr. Kingzett makes a statement which cannot be admitted. He writes:—"The treatment of sewage, as here referred to, means the removal therefrom of the whole of the suspended matters, but it does not seriously affect the composition of the liquid part (effluent) which is then discharged into the river." But, if the treatment is properly performed, soluble organic matter, such as soluble albumen, will be coagulated, precipitated, and removed. We may withdraw from town sewage, by the most careful and reiterated filtration, all suspended matter. Yet on adding to the filtrate solutions of certain metallic salts,—preferably perhaps of aluminium chloride,—a precipitate is produced consisting of a compound resembling the "lakes" of the colour-maker and the dyer.

In examining the dogma of the Rivers' Commissioners, that "Rivers which have received sewage, even if that sewage has been purified before its discharge, are not safe sources of potable water," Mr. Kingzett presses the question—How is it, considering the quantity of organic matter introduced into the Thames, that its water is so comparatively pure? He points to the various agencies, organic and inorganic, which take part in this purification. According to some experiments made by Prof. W. Odling the water of the Thames loses daily, in passing from Teddington Lock to Somerset House, from 12 to 13 tons of oxygen. It is indeed difficult to say what can have become of this oxygen unless it has been employed in oxidising, or, in plain English, burning up the impurities.

It is of course contended that, whilst dead organic matter is thus burnt up, living organisms—disease-germs—resist. We are told of experiments said to have been made upon them with poisonous gases. If the results described were really obtained it may be asked whether the chemicals used are poisons for these particular organisms, or are inhaled by them at all? We have imprisoned specimens of an animal, very much higher in the scale of being, *Callidium violaceum*, in an atmosphere of hydrocyanic acid, without effect. Other poisons, on the contrary, proved effectual.

In reply to Dr. Hogg's celebrated Caterham case, where a workman suffering from enteric fever had defiled the well, and thus occasioned a disastrous epidemic among consumers of the water, the author shows that the water, though largely diluted,

"was immediately delivered for consumption, and certainly was not exposed to those conditions which must be accepted as constituting purifying influences."

It may be here remarked that, concerning the withdrawal of disease germs from water, doctors differ. Unless we are greatly mistaken Prof. Frankland has asserted that water may be freed from bacilli, &c., by being passed through a "spongy iron" filter. Dr. Jabez Hogg, on the contrary, has found such water plentifully stocked with microbia.

Mention is made of the very instructive statistics compiled by Mr. Baldwin Latham, from which it appears that the death-rate from diarrhœa in the districts supplied by the Thames water-companies is actually *lower*, though only to a slight extent, than that prevailing in the districts supplied from the deep wells of the Kent Company. "Such a fact as this," he justly remarks, "is simply irresistible."

Concerning the means of judging of the fitness or unfitness of a water for drinking purposes some difference of opinion prevails. The author relies, it seems, on chemical analysis. He writes:—"By the logical use of the results obtained from the analysis of waters, combined with a knowledge of their history, it is not difficult for chemists to form a sound judgment as to whether they are or are not fit for drinking purposes, notwithstanding all that has been said to the contrary by engineers and biologists. If chemists cannot pronounce positively concerning the presence or absence of disease-germs in water, they can at least ascertain from its composition and history whether it is likely to contain them or not. Engineers can do nothing in this direction, and biologists cannot provide a better test of the purity of water."

We submit that the history of a water is as open to the engineer or the biologist as to the chemist. Chemical analysis may, by direct or indirect methods, ascertain what proportion of carbon and of nitrogen in organic compounds is present. But it is unable to say whether such nitrogen and carbon have been derived from the bodies of disease-microbia or from lifeless inorganic matter.

In his chapter on the treatment of sewage, the author very justly remarks that "precipitation by lime yields an effluent which, from its comparative impurity and alkaline character, soon passes into a state of putrefaction, and the lime in solution is fatal to the fish in river-water."

The farcical proceedings of the Metropolitan Board of Works at Barking and Crossness receive the estimate which they justly merit.

We regret that, from want of space, we cannot at present enter upon a discussion of the author's views on the propagation of disease, the more as he does not implicitly accept the prevailing germ-theory.

Magnetism and Electricity. By F. GUTHRIE. With Supplementary Chapter by C. VERNON BOYS, A.R.I.M. London and Glasgow: W. Collins, Sons, and Co., Limited.

THIS work commends itself to us as containing no reference to any "syllabus," and as being not disfigured with a tail in the shape of questions set at any examinations. It is, as the author informs us, intended for the general student. He also draws an often-forgotten line between Science and Art,—one of the definite boundaries, now possible,—and "where the Science becomes an Art" he does not go into details except the Art supplies a good illustration of some scientific principle.

The "Supplementary Chapter," on the contrary, is devoted to inventions rather than discoveries. It describes, therefore, the telephone, the microphone, various forms of dynamo-machines, the principles of electric lighting, and accumulators, and explains the units now so much employed by electrical engineers.

The brief but ably written chapter on Electricity in Relation to Life is valuable as cutting away the ground from under a certain school of charlatans, and showing how little definite foundation there is for the vulgar notion that electricity is identical with, or at least very near of kin to, life.

This work is one we can in good faith recommend to the general reader who wishes for a rational exposition of the properties and the possibilities of electricity.

Records of the Geological Survey of India. Vol. XVI., Part 4.

AMONG the most interesting papers in this issue is a notice, by Mr. F. R. Mallet, on Native Lead from Maulmain and Chromite from the Andaman Islands. The lead ore in question, obtained by Mr. G. H. Law, is a carbonate of lead tinged bright red by minium. It contains small cavities lined with tiny white crystals of cerussite, and some of them are also partly filled with metallic lead.

Chromite, apparently in quantity, has been found near Port Blair, in the Andaman Islands.

The fiery eruption from one of the mud volcanoes of Cheduba Island, Arakan, noticed on May 2nd, 1883, was evidently due to the ignition of petroleum or of a gaseous hydrocarbon gas. The flame is said to have risen at first to the surprising height of 900 feet.

Records of the Geological Survey of India. Vol. XVII., Parts 1 to 4.

Dr. W. King contributes a memoir on the "Smooth Water Anchorages" of Narrakal and Alleppy, on the Travancore coast. There are two anchorages on this coast which are perfectly smooth and quiet, even though the sea outside is tumbling in before the gales of a south-westerly monsoon. The bottom of these anchorages is composed of a soft, unctuous mud, portions of which, on analysis, are found to contain oil. There appear to be deposits of petroleum, either underneath the sea-bottom or along the coast, from which oil gradually oozes up, and calms the otherwise troubled waters in the manner which has of late attracted so much attention, especially since the Peterhead experiment. To keep up the tranquillity of surface the supply of oil must be continuous.

Mr. R. Bruce Foote, F.G.S., describes the caves of the Kurnool district. The exploration was rendered difficult by the swarms of cliff-bees, *Apis dorsala*, insects of a very uncertain temper.

Mr. R. D. Oldham gives an account of the earthquake of December 31st, 1881, which seems to have been felt over a region 1600 miles from north to south, and 1500 from east to west.

Mr. G. F. Scott, M.E., reports on the Choi coal exploration. He announces that the prospect of finding a sufficiency of workable coal, either at Choi, Mungi, or the country to the east and west of the points, is doubtful. The coal, moreover, is but of a poor quality.

Mr. R. D. Oldham has re-discovered the "long-lost fossil locality described by Sir Proby Cantley, at the base of the section in the Siwalik Hills."

Mr. F. R. Mallet reports on the mineral resources of the Andaman Islands in the neighbourhood of Port Blair. The pyrites of these islands, so far, are of a very low quality. It is remarked that "the poorest class of ore in the English market contains about three times as much sulphur as that of Ráng-u-Cháng. The pyritic quartz has been assayed for gold and silver, and is found to contain none. The writer considers that there is a deposit of chromite, but doubts strongly that it is a large or continuous one. Platinum, which often occurs in connection with chromite, was searched for, but not a single particle was found.

Col. E. B. Sladon gives an account of a further fiery eruption from one of the mud volcanoes in Cheduba Island. On this occasion the flame is said to have been 2400 feet in height and 600 feet in circumference, giving off dense smoke and a smell of petroleum.

Dr. W. King gives a favourable preliminary report on the Raijarrh-Hingir coal-field, and points out localities for borings.

T. D. La Touche and T. W. H. Hughes report on the Langrin and Almaria coal-fields. In the former of these districts the prospects for remunerative coal-mining are very fair. The coal contains but a small proportion of ash, and would hence be suitable for burning the lime which is quarried at the foot of the hills.

At Almaria the position is still better, there being an abundant store of coal fit for railway purposes, and occurring in a working thickness of at least 7 feet. It lies near the surface, the dip is slight, and the coal-measures are not very watery.

Dr. King describes the auriferous sands of the Subansiri River, in Assam. He finds that the yield of 26 ozs. per ton was obtained from a minute portion of sand, and not at all representing the actual output on the large scale. In practical operations in the Lakhimpur district the entire quantity obtained from 2½ tons of stuff was only 30 grains!

The phosphatic beds of Musun afford deposits of phosphate of alumina, containing in the nodules 45·17 per cent phosphoric acid, and in the rock 41·8 per cent.

Mr. R. Bruce Foote resumes his examination of the Billa Surgam Caves. In the so-called Charnel-House Cave traces of prehistoric man were found, at the depths of 15 and 16 feet below the surface, in the shape of a well-made bone gouge and two pieces of stag-horn which had been cut with some sharp instrument. A rude bone-knife was also found in the Cathedral Cave. Bones and teeth of many animal species were found, but their determination was in many cases impracticable on account of the deficiency of the osteological collections at Madras. The caves do not appear to have been the prolonged residence of any Carnivora. The most interesting facts are the discovery of two species of the genus *Equus*, hitherto unknown in Peninsular India, and of a second species of rhinoceros, quite distinct from *R. indicus*, but approaching *R. javanicus*.

Report on the Cotton Production of the State of Alabama, with a Discussion of the General Agricultural Features of the State. By E. A. Smith, Ph.D., State Geologist and Professor of Chemistry and Geology in the University of Alabama.

The climate of Alabama is by no means what might be expected from its latitude, its proximity to warm seas, and from the absence of high mountain ridges. Though the mean annual

temperature reaches 64·58° F., and that of the winter 50·4° F.,—higher, in fact, than that of the South of England,—frost is no exceptional phenomenon. In Montgomery, at about 32·4° N. lat., the last frost occurs, as a rule, between the 5th and 25th of April, "and when the last frost is recorded in March its actual formation in April is prevented by unfavourable conditions, such as cloudy weather." In the autumn the first frosts are usually experienced between October 10th and 25th. Thus little more than five months out of the twelve are absolutely safe from frost. In the more northern parts of the State there is usually at least one considerable fall of snow during the winter.

Concerning the local incidence of frosts an observation is made which coincides with experience in England and on the European continent. Frost is often more destructive in valleys than on the hills. This phenomenon is thus accounted for:—As the air is cooled it becomes more dense, and in consequence flows down the slopes to the lower levels, where it accumulates. The elevated lands are thus never exposed to the full intensity of frosts, for their position affords a ready way for the escape of the cooled air, which flows down the slopes as fast as formed, and the reduction of temperature is in this way greatly retarded. On the other hand, the lowlands not only retain the cold air caused by their own radiation, but serve also as reservoirs for the cold air descending from the adjoining heights. Hence narrow valleys and plains extending towards the foot of hills are necessarily less favourable for the growth of cotton, and other crops impatient of cold, than are hills of a moderate elevation.

Report on the Cotton Production of the State of Florida, with an Account of the General Agricultural Features of the State. By E. A Smith, Ph.D.

A fauna and flora of Florida would be for the naturalist a document of surpassing value, especially as both will shortly undergo destructive changes from drainage operations and from the projected ship-canal. We find a list here of the most common timber-trees, shrubs, and weeds. One of the most troublesome of the latter is the yellow dog-fennel (*Helenium tenuifolium*). "It is eaten in the spring-time by cattle, and imparts an intensely bitter taste to the milk."

Considering the low latitude of this State (24° 30′ to 31° N. lat.) and the absence of eminences reaching 300 feet, the climate of this State should be semi-tropical. Still frost is not altogether

excluded, since we read of the temperature in winter seldom falling much below 32° F.

The peninsular part of Florida was probably elevated above at the end of the Upper Eocene. During the Middle and Upper Tertiary epochs it is probable that Florida was much broader than at present, and that the western coast lay 100—or in some places 150—miles beyond its present position.

One of the most interesting geological features, from an economic point of view, is the plentiful occurrence of a soft limestone, which in some places contains as much as 16 per cent of phosphoric acid.

The Higher Branch of Science or Materialism refuted by Facts. By H. J. Browne. A Paper read at the Hall of Science, Melbourne, Aug. 15th, 1884, which was written with the intention of being read at a meeting of the Royal Society of Victoria, but which was declined by the Council of that Conservative Association. Melbourne: W. H. Terry.

Mr. H. J. Browne is a man with a grievance. When his paper was declined he appears to have written to the President of the Royal Society requesting that his name might be erased from the list of members of the Royal Society, but being good enough to promise that "when the Society becomes less illiberal and intolerant towards anything that does not accord with received theories, I may allow my name to be reinstated, and if so, I shall take an opportunity of bringing this episode under the notice of the Society."

Without any wish to hurt the author's susceptibilities we must say that had he served on the Council of any scientific society he would have learnt that in discussing the suitability of any paper offered, *two* questions are raised: Is the subject suitable, and is it treated in a worthy manner? Now, in criticising this paper the first question we ask is: where is the science? Mere facts, even if in quantity sufficient to form a shower-bath, do not constitute science. They require to be co-ordinated. Now, this task, so far as we can see, is not even attempted in the work before us. Facts are referred to which it is by no means our purpose to call in question. There is abundance of reiterated complaint about the obstinate materialists who will not "condescend" to their investigation. The opinions of eminent men in favour of Spiritualism are quoted, and there is the *banal* enumeration of cases where truths now generally recognised have been received with ridicule, persecution, or neglect. But calm reflection would tell the author that though truth has often been

thus ill-treated, every opinion which is despised and rejected is not necessarily truth. Now all this matter which forms the staple of the book, is scarcely well fitted for the transactions of a learned society. Had the author, instead, stated certain verified facts, explained what they prove, and traced them to definite laws, or even attempted so to do, he would probably have met with a very different reception at the hands of that "Conservative Association."

We all know that—to take a simple instance—the publication of the "Origin of Species" roused a violent storm of opposition. Yet we can find no case where Darwin gave vent to Jeremiads on the obstinacy, the prejudice, or the preconceptions of his gainsayers.

But we find Mr. Browne committing certain palpable errors. He writes:—"It is said that nine-tenths of the men of science of to-day are Agnostics, which I hold is merely a milder and more respectable name for Atheists or Materialists." Now we have certainly no authority to speak as the representative of Agnosticism, which would doubtless, if occasion served, calmly refer us to some sub-species or variety of the "*genus* Humbug." But we regret to find a writer who pleads for the dismissal of prejudice and for the candid judgment of opponents confounding positions so distinctly different as those of the Atheist and the Agnostic.

On the next page is an abuse of language which is of itself enough to justify the rejection of Mr. Browne's paper, unless he had consented to its correction. He writes:—"Those who have witnessed the wonderful phenomena of Mesmerism, *Biology* (!), Hypnotism, and Clairvoyance, &c." Again, a few lines lower down, we read:—"And I hold that no one has the right to deny the truth of Mesmerism, *Biology*, Hypnotism, or Clairvoyance, &c." Now surely Mr. Browne must know that the term biology, meaning the science of living beings, was pre-engaged long before certain persons thought proper, quackishly, to use it for a certain method of producing a state very similar to, if not identical with, Hypnotism. The expression first coined was "electro-biology," but when it was found that a disk of a single metal, or of wood, or horn, &c., placed in the palm of the hand and gazed at persistently answered the same purpose as the compound disc of zinc and copper, the prefix "electro" was dropped, and the new process or method of producing Hypnotism was impertinently and ignorantly named Biology. We should recommend Mr. Browne to purge his pamphlet from this defect.

There is another point on which we must join issue with the author. Unless we fail to understand him he clings to the old notion of an absolute barrier between man and the rest of the organic world. He writes:—"As below man is the animal kingdom, so above him is the spirit-world." Now the very same arguments which may be urged in favour of man's continuance

after death tell in favour of a future life for the lower animals also. More; not a few Spiritualists testify to the reappearance of deceased dogs, cage-birds, &c. But we hope that the author, who admits himself a believer in Evolution, does not literally uphold the doctrine of the "great gulf" separating man from the anthropoids.

Second Annual Report of the Metropolitan Public Garden, Boulevard, and Playground Association. 1884.

We have here the report of a Society which in an unobtrusive way is effecting a good work. We fully admit the general truthfulness of the sad picture here drawn of the condition of a large part of the metropolitan population. The question, what can be done to reduce the "din and uproar,"—"the whirl and hurry, slavery and closeness," among which the majority of Londoners live and die, is becoming more and more pressing. Among the various agencies operating in the right direction the formation of public gardens, parks, and playgrounds wherever practicable is not one of the least valuable. Every increase to the small stock of what is beautiful amidst the general squalor and ugliness of this overgrown city must have, as far as it goes, a humanising influence, especially upon the young. The public may be congratulated on the passing of an Act which prohibits the erection of buildings upon disused burial grounds. This measure, by depriving such land of all value to the building speculator, renders its acquisition for the formation of public gardens easier. We may, however, regret the squeamishness which dictated the clause forbidding the playing of games in such grounds.

The Association seems to have been very fairly successful in its operations. As a rule local authorities, landowners, incumbents of churches, &c., have shown themselves desirous of aiding the work of the Association. Occasionally, however, their proposals have been declined. Two instances are given of vestries which at first received the subject favourably, but at the last moment suddenly and unaccountably changed their minds. Two of the City Companies have rejected the scheme for throwing open certain plots of land, and certain boards of trustees have adopted a similar policy.

We venture here to suggest that the Association should, if possible, endeavour to secure for the public that portion of the Alexandra Park known as "The Grove," containing trees which are simply magnificent, and if destroyed, could never be replaced. Should the ground ever be sold, as is not unlikely, these trees will assuredly be hacked down by some wretched building-

speculator, and their lovely site will be desecrated by the erection of gingerbread villas, replete with every kind of modern bad taste.

In conclusion we must beg to point to one circumstance which may have its weight with individuals and public bodies who decline to accept the proposals of the Association. Agitation has been set on foot in various districts for rescinding the salutary provision that the public parks, such as Battersea, Victoria, Finsbury, &c., shall not be used for "public meetings." It is certainly intolerable that grounds provided for the recreation of the whole public should be liable at any moment to be seized upon by the most turbulent portion of the population for gatherings which, whatever the intention of their promoters, never fail to draw together the criminal and semi-criminal classes. We believe that if some absolute security against this movement could be obtained, the Association would find its funds increased, and would rarely, very rarely indeed, meet with refusal or even hesitation on the part of persons interested.

The Agnostic: a Monthly Journal of Liberal Thought. Vol. I. Nos. 1 and 2. London: H. Cattell and Co.

In this new journal we find matter differing greatly both in its tendencies, and as it appears to us, in its value also. We first notice on the very title-page the expression "liberal thought," and on futher examination we meet with such phrases as "the liberal public,"—"the liberal movement,"—a "Religious Liberalism," &c. Now we submit that the terms thus used stand in some need of being sharply defined. What is "liberal" thought, and how does it differ from thought which is non-liberal, or which is anti-liberal? Precision is here all the more needed since the word liberal has been adopted as the badge of a political party.

But to the matter before us. G. M. McC. contributes two subtle and thoughtful papers on the "Confession of Agnosticism." In the former of these he contends that "here and now" there are undoubtedly two worlds, to the confusion of popular Secularism. The Secular philosophy he pronounces "a part of the truth, but not the whole." In the second essay he strives to clear away certain misconceptions. He protests against "the utter emptiness of our present labelling systems." With equal force and truth he writes:—"The question of the modern Athenian is not what is the new thing of the day? but, what is it called? And the verdict he delivers depends upon the name—that is the stamp or label affixed to the novelty—and not upon the reality itself, the inward part or thing signified."

True, but not novelties only. We are ruled by catch-words.

But surely now we begin to see that in the organic world species melts gradually into species, we might apply this great truth to our classifications of men.

"An Exposition of Herbert Spencer's Philosophy," by Ignotus, has the very valuable feature of presenting in parallel columns the leading propositions of the Synthetic Philosophy, and of Positivism. How the latter can in these days find any acceptance at all is to us a most painful riddle.

Dr. W. B. Carpenter, in a reply to Captain W. B. McTaggart, sets forth the intellectual basis of his own (peculiar) Theistic belief, and seems greatly scandalised at the gallant Captain's slightly irreverent rejoinder.

The two papers, by Julian, on "The Popular Religious Faith," lie most distinctly outside our competence.

"Man: Whence and Whither?" is considered in two papers by Dr. H. J. Hardwicke. The learned doctor is most emphatically right in denying that the faculty of speech in man forms an absolute boundary line between him and the lower animals. How could the dog possibly understand human language unless capable of receiving from his companions very definite information through the medium of sound?

We may, however, raise a doubt when we are told of the chimpanzee and gorilla families of Africa "walking on their hind-legs only."

The submerged continent of "Lemuria" has, indeed, been denied by high authorities, but almost in the same breath is admitted the probable existence of several large islands, stretching north-eastwards towards Ceylon and Sumatra.

The ability manifest in most of the articles which have hitherto appeared in the "Agnostic" is indisputable. The question may, however, arise, how far will it be possible to prolong the discussion of Agnosticism and its applications?

Magneto- and Dynamo-Electric Machines, with a Decription of Electric Accumulators. From the German of Glaser de Cew. By F. Krohn, and especially edited, with many additions, by Paget Higgs, LL.D., D.Sc. London: Symons and Co.

Works relating to electricity and its practical applications appear to be increasing at a rate similar to that which has until lately been the case with chemical manuals. The difficulty will soon be to decide what special advantage or superiority one work of this kind presents as compared with another.

The author,—or authors,—of the present treatise set out with a history of the development of magneto- and dynamo-electric

"generators," a word which is gradually becoming naturalised in England. They then discuss the machines for direct and indirect currents and the peculiar uses and applications of each kind. They next explain automatic switches and the regulation of currents.

We are then introduced to the question of electrical storage, with especial notice of the accumulators of Planté, Faure, and others. We must plead guilty of an especial veneration for accumulators. For do they not fully typify the man of the time,—the student who has prepared for and duly passed his examinations, and is now prepared to let out what has been instilled into him *minus* a certain inevitable percentage of loss?

The sixth and seventh chapters deal with the physical laws bearing on generators and the construction of their several parts.

In the notice of the employment of the machines in question for the production of electric lights we find an explanation in detail of the advantages of large generators.

The last chapter of the work treats of the use of electricity as supplied by these machines for plating, gilding, nickeling, &c., for purifying metals and preparing ozone, and for melting the most refractory metals.

The author concludes the body of the work with an anticipation of the time when energy will be transmitted in the form of electric currents to all the houses of a town, there to be transformed at pleasure into heat, light, or motive power. We may rest assured that so long as the present state of the law continues, this picture will not be realised in Britain.

Four supplementary chapters then follow, giving formulæ for the construction of electro-magnets, describing instruments for measurement, and the latest constructions of generators. Finally, we have the complete mathematical theory of magneto- and dynamo-electric machines as developed by Clausius.

Smoke Abatement. Report of Council of the National Smoke Abatement Institution, submitted at the Ordinary General Meeting Dec. 22nd, 1884. Offices of the Institution: 74, Margaret Street, W.

THE most striking feature in this pamphlet is the expression of a desire that the smoke-prevention Acts should at no distant date be so modified as to entend to dwelling-houses. We fail to see how any such measure could be put in force without inflicting great hardships upon the householder, who already sees his local burdens continually increasing, and his income at the same time diminishing. Between a factory and a dwelling-house there are certain capital distinctions which smoke abators do not duly take

into consideration. A factory, if not the freehold of its occupier, is generally held on a long lease. Hence he can fairly be called upon to undertake improvements, and he may, with some show of reason, be told that the reduced consumption of fuel will compensate him, before the expiry of his lease, for the outlay incurred.

With dwelling-houses all this is different. In a vast majority of cases they are occupied by monthly, quarterly, or yearly tenants who have no permanent interest in them, and whose term of occupancy will not—except where they are combined with shops or warehouses—exceed three years. Now to call upon such persons to expend a considerable sum of money in structural alterations when they may, perhaps, at the next rent-day give or receive notice to quit, might surely be called a harsh proceeding.

Any one who knows the British workman of the present day will not, we are sure, consider £2 as too high an estimate for the alteration of a simple fire-grate so as to be smoke-consuming. To subject a man to incessant prosecutions and fines because he has not the means for making these alterations would be deservedly unpopular. Perhaps smoke abaters may say, let the landlord undertake the change required. If so he would certainly charge a most usurious interest on his outlay. Where, again, is the guarantee that the new stoves introduced would be efficient, and if they failed to give satisfaction who would be held responsible?

Further, smoke consumption or smoke prevention will always remain unsatisfactory without we can largely diminish the quantity of coal consumed. For the injury to vegetation, and to objects of stone or metal exposed to the air, depends mainly on the sulphur present in the coal, and which, during burning, is converted into sulphurous acid. Now this sulphurous acid is not in the least diminished by getting rid of all the visible portions of smoke.

From these considerations, and also because we know something about Royal Commissions, we are not sorry that the present Government is "not disposed to grant the application for a Royal Commission" to investigate the smoke nuisance.

It must not be inferred from what we have just said that we are indifferent to the evils of smoke. Although we consider it a mere molehill in comparison with certain other factors which promote national debility, we heartily wish its abolition, though we hold that this "reform," like many others, may be purchased too dearly.

We fully agree with the proposals brought forward at the end of this report, *viz.*, that the boundaries within which the Metropolitan Smoke Act of 1853 holds good should be extended, and that its provisions should be more fully and firmly applied "to steam-boats, locomotives, &c." We should also urge the total prohibition of ballast-burning within the boundaries above-

mentioned. We should like to see German stoves, of glazed stone-ware tiles, introduced in all houses hereafter built or rebuilt. By this step we should reduce the consumption of coal and the production of smoke by 75 per cent, and give the London coal-ring its death blow.

Our Corner. A Monthly Magazine of Fiction, Poetry, Politics, Science, Art, Literature. Vol. V., Nos. 1 and 2. January and February, 1885.

"A SOUTHERN Shell," by Mr. W. Mawer, is a pleasing study of certain mollusks.

As a continuation of "Our Household Pests" comes a chapter on the Spider, which, by the way, has but doubtful claims to rank as a pest. We do not, like the author, "really feel conscious of a kind of revengeful sentiment upon seeing a spider pounce eagerly upon a struggling fly, gnat, or other dipteron." We are too glad of any aid in thinning those *colporteurs* of infection and pollution, the two-winged flies. But if Madame Arachne entraps a bee, a butterfly, or a beetle, we draw a distinction, and think that the strong-minded lady is acting in excess of her rights. But useful as spiders are, they are scarcely to be loved. When shall we know the nature of their poison?

The same author next discusses the cockroach, which is beyond all contradiction a "household pest." The author points out with perfect accuracy the characters, morphological and embryological, which prove that the cockroach is not a beetle. But he will only lose his labour.

Why is it, we often ask, that foreign weeds and foreign vermin easily get acclimatised in any country, whilst harmless, beautiful, or useful species scarcely ever become truly naturalised? The cockroach and the bed-bug, both aliens, have made themselves quite at home in Britain. But all attempts to introduce *Carabus auratus* (*Le jardinier*) and *Calosoma sycophanta* have failed. Both these insects are useful to the farmer and the gardener, both are beautiful, and both are fairly common on the Continent. Nay, why is it that in spite of all our exertions the foulest weeds hold their ground in our midst, while botanists in all parts of the kingdom lament that lovely plants, such as many of the ferns, are verging on extirpation?

We sympathise with the question raised under "Science Corner":—"When will the resources of Science be used only for the preservation, not for the destruction, of life? Men, not

content with murdering each other on the surface of the ground, hope soon to grapple with each other in the air and to struggle beneath the waves?" When, ndeed?

Our Corner. No. 3. March, 1885.

In the current number of this somewhat heterodox journal we find some very interesting matter.

In the account of the trial of Mr. C. Bradlaugh and Mrs. A. Besant, for selling the "Fruits of Philosophy," we are told that Dr. W. Carpenter "rudely said that he was not responsible for 'Human Physiology by Dr. Carpenter,' as his responsibility had ceased with the fifth edition." It seems to us that the learned doctor's position is scarcely justifiable. In the paper before us it is, not unnaturally, pronounced "a strange thing that a man of eminence, presumably a man of honour, should disavow all responsibility for a book which bears his name on the title-page. Clearly, if the 'Human Physiology' is not Dr. Carpenter's, the public is grossly deceived by the pretence that it is, and if, as Dr. Carpenter says, the whole responsibility rests on Dr. Power, then that gentleman should have the whole credit of that very useful book. It is not right that Dr. Carpenter should have all the glory, and Dr. Power all the annoyance, resulting from the work," which it appears is given to young boys and girls as a prize in Government examinations.

It appears that it was the intention of the defendants in this trial to subpœna Charles Darwin. He wrote to them, however, stating that in his opinion "over-multiplication was useful, since it caused a struggle for existence in which only the strongest and the ablest survived."

We need scarcely say that on this point, as on certain others, we disagree with Darwin. We doubt whether those who survive the struggle, in the present organisation of society, are "the strongest and the ablest," or rather those who are not completely dominated by greed. It is practically certain that though a struggle for existence may, up to a certain point, have beneficial effects, yet, just as is the case with heat, light, or moisture, when too much intensified, it becomes destructive.

Mr. Monoure Conway, in criticising O. Wendell Holmes's "Life of Emerson," remarks that "in estimating the relation of Emerson to Science he seems to have hardly done him full justice." Certain lines of Emerson, printed in 1849, are pronounced to have anticipated the discovery of Darwin by ten years. It is suggested that "probably" a lecture on the

"Relation of Man to the Globe," delivered by Emerson as far back as 1833, "will be found to contain a theory of Evolution similar to that popularised eleven years later." But the merit of Darwin lies not in his having been the first to suggest the idea of Organic Evolution, which he certainly was not, but in his working the subject out and placing it on a definite foundation.

Mr. Alexander Dunbar, in an article entitled "The Wages of Unrighteousness," makes the singular remark that "it would be well if all a clergyman's spare time were spent in knocking balls about and worrying dumb animals." We always feel a grudge against anyone who uses the cant expression "dumb animals." The majority of vertebrates and arthropods are not "dumb" in any rational sense of the word, and, in ninety-nine cases out of a hundred, if an animal is truthfully designated as "dumb," its dumbness is quite irrelevant.

Elsewhere the same writer remarks, very justly, "There is so much to be done in every department of human knowledge which is not profitable that it seems almost a duty for anyone with means and leisure to take up some work of the sort. There is probably not a country parish in England in which a diligent naturalist might not make useful observations." But unfortunately the tendency of the age is more and more to prevent anyone from having both means and leisure.

"Evolution as its own End" is not, we think, a memoir of the kind which most readers would expect from its title.

In an address delivered, or supposed to have been delivered, by a condemned criminal in France, we find some significant passages. Concerning the apprenticeship system, the only gateway at present to a practical acquaintance with any mechanical trade, he says—"Labour! don't believe it. The apprentice is the common fag; he goes on errands; he endures curses and kicks from the older men, but he *works* little or not at all;" and again, Society "knows that the atmosphere of the workshop, morally and physically, is injurious to the very young and the untrained, and it permits them to be sent into those dens which seem made to corrupt the mind and debilitate the body." Who, after reading such confessions, will not congratulate himself on being under the industrial *régime*, lauded by the modern apostle Comte and by others? It is to be noted, further, that the criminal says—"My father was a drunkard, my mother a hysterical epileptic." Could Society by any means train the offspring of such parents to be other than a curse?

The Fern Portfolio. By F. G. HEATH. London: Society for Promoting Christian Knowledge.

THIS is, we believe, a publication unique in its kind. All the species of British Ferns are here not merely described, but faithfully depicted in coloured plates, 16 by 12 inches in size. An entire frond in life-size is given in every case but two, the Royal Osmond and the Bracken, which are too large. These plates are exquisitely accurate, and therefore, to the loving eye of the naturalist, perfectly beautiful. The venation, even of the smallest parts, is carefully reproduced. The highest praise is due to the author for the enthusiasm, the devotion, and the patience which have been expended on his task, and we are glad to have the opportunity of congratulating him on the success which he has achieved.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

"DUMB ANIMALS."

CAN you or any of your correspondents inform me when the cant expression "dumb animals," for all animals save man, originated, and who was its author? In the sense in which it is used in England it is, I believe, unknown in other civilised countries. To the best of my knowledge if a German were to mention "die stummen Thiere" he would be understood to mean merely those animals which are incapable of communicating with their like by sound.

GRADUATE.

[We believe the phrase is a survival. The ancient Greeks called all aliens "dumb." It is now chiefly used by Bestiarians who conceive that it adds weight to their utterances.—ED. J. S.]

NOTES.

Mr. Charles C. Cattell, the Secretary of the Darwin Institute, Birmingham, persists in insinuating that Mr. Darwin was atheistically inclined. In an address on "Charles Darwin, and what led to and sustains his Theory" (undated, but evidently recently published), this writer admirably arrays certain of Mr. Darwin's manifold indictments of the doctrine of design, and remarks that "In his first work, when under the influence of the old idea, he only attributed to the Creator the origination of life, and assumed the existence of only a few original forms, perhaps four or five." Mr. Cattell is perhaps unaware that in the second edition, revised, of the "Variation under Domestication" (1875), Mr. Darwin implied a continuance of belief in this doctrine (*vide* p. 12, vol. i.). Similar movements on the part of the Secretary of the Darwin Institute have been noted in this Journal for August and December of last year (pp. 490 to 492, and p. 729).

Mr. E. Gilpin, F.G.S., in a paper read before the Geological Section of the British Association, anticipates a permanent and profitable future for the gold-mines of Nova Scotia.

M. H. Beauregard ("Comptes Rendus") studies the digestive apparatus of the Cantharidæ. Its three portions—the œsophagus, the stomach, and the intestine—are divided by two valves placed at the anterior and posterior extremities of the stomach. The anterior valve offers three types, occurring respectively in *Epicauta* and *Lytta*, in *Cantharis* and *Mylabris*, and in *Meloe*.

Prof. Plateau concludes, from a series of experiments, that the contractile force of the muscular fibre is not the same in all animals.

Gerhard Krüss ("Berlin Berichte") calls attention to the influence of temperature in spectroscopic observations. By an increase of temperature all phenomena of absorption and emission are removed towards the violet end of the spectrum if glass prisms are employed, and towards the red end in case of quartz prisms. These displacements are generally greater when they occur in the more refrangible regions of the spectrum.

"Science" complains of the neglect of the entomological collections in American museums. We fear that such carelessness is not confined merely to America.

Dr. E. B. Tylor remarks that the moment that anthropologists take to cultivating their science as a party weapon in religion and politics, this will vitiate their reasonings and spoil the scientific character of their work.

Dr. Harrison ("Canada Lancet") records the strange fact of a sick child voiding a large number of the pupæ of the Colorado beetle. The insects did not seem the worse for their abnormal sojourn.

Liquefied carbonic acid is spoken of among German engineers as "the power of the future."

Mr. Ruskin justly complains that "the whole force of education until very lately has been devoted in every way to the destruction of the love of Nature. The only knowledge which has been considered essential is that of words, and next of abstractions."

According to a contemporary, in an examination on physiology some years ago, at South Kensington, the question was put, "What is bile, and what are its uses?" One candidate's answer was "Bile is formed in the stomach, and is used for cleaning carpets."

Mr. Cope Whitehouse maintains, in "Van Nostrand's Engineering Magazine," that the artificial Lake Mœris must have had the dimensions ascribed to it by Herodotus and Ptolemy, and that the Pyramids, including that of Cheops, were formed from the rocks cut away, the stones being not raised up, but let down to their present positions.

We cannot adequately express our regret at finding that Mr. A. R. Wallace has descended into the region of politics.

"Light" writes:—"Now we protest emphatically against any attempt to suppress the search after truth, in whatever realm, natural or supernatural, by an appeal to the strong [better 'blundering'] arm of the law." Surely a denunciation of the Anti-Vivisection Act, as well as of the "Slade prosecution."

A writer in the "Popular Science Monthly" complains that an education in Germany fills a youth "with a love of research for its own sake, not for the sake of its direct bearing upon practical results." Precisely so; and without this love neither man nor nation will ever become great in Scicnce.

Dr. F. Müller shows that the excrement of Carnivora, fed upon pure flesh, is essentially a secretion from the intestinal canal, and not a residuum from the food ingested.

M. Pasteur proposes, as an interesting series of experiments, to feed young animals from their birth exclusively upon *pure*

nutritive matter,—*i.e.*, such as has been artificially and completely deprived of microbia.

M. A. Villiers ("Comptes Rendus") is studying the formation of ptomaines in the animal organism, during certain diseases.

Mr. W. S. Green has discovered the Alpine Edelweiss growing on the high mountains of New Zealand.

Military and political spies in Asia and Africa now pose as geographical and zoological explorers, and mask their real aims beneath the wings of 17,000 specimens of Lepidoptera.

The total proportion of phosphorus in the brain of a horse is, according to Dr. Baumstark, 0·347 per cent, or, if calculated on the dry matter, 1·297 per cent.

Says a writer in "Science,"—"The time may come when it will be not unusual to study 'veridical phantasms' by polarised light, and to observe their behaviour in a magnetic field."

M. Faye ("Comptes Rendus") notes that sun-spots proceed rapidly from the minimum to the maximum, and they decline slowly towards the next minimum. The same is the case with almost all the fixed stars.

E. Dönhoff ("Archiv. für Anatomie und Physiologie" has discovered in the intestine of the larva of the "wax moth" (*Galleria cereana ?*) a special ferment capable of decomposing wax.

P. Baumstark (("Zeitschrift f. Physiologische Chemie" has succeeded in establishing the presence of protagon in the brain as a definite compound.

It is noticed in the "Zeitschrift für Analytische Chemie" (xxiv., p. 135) that bees perish if fed upon glucose.

According to the researches instituted by J. Förster ("Archiv. für Hygiene") borax is an objectionable ingredient in human food, as interfering with the utilisation of some of its constituents and increasing the secretion of mucus in the intestinal canal.

From observations made in France the phenomena of vegetable life are retarded by a mean of four days for each additional 100 metres of altitude. The arrival of the chimney swallow is delayed by two days for each 100 metres.

Mr. R. Brudenell Carter, in a lecture on the influence of civilisation upon eyesight, remarked that he had offered the London School Board to examine the eyes of the school-children, but his offer "was declined in an uncivil letter, written in very bad English."

Mr. Atkins ("British Pharm. Confer."), when at Vevey, was told by a large vine-grower that the grapes of one field, which had the afternoon sun, produced a wine of a much higher quality than the vines which had the morning sun.

The Dutch Society of Sciences, at Harlem, offers prizes for new researches on the quantity of heat radiating from stars of the first, and if possible of the second, magnitude, having regard to the heat absorbed by the atmosphere and by the lenses; also for an examination of the results hitherto reached in the study of the specific volume of liquids or solids; also for new observations and experiments on the pathological phenomena occasioned in man and other animals by certain bacteria; also for a precise study of the history of the development of some species of Annelida; also for a study of the means applied or proposed for determining the influence of the ironwork of ships upon the compass, and for the complete or partial elimination of this influence. Memoirs in reply to these questions, each accompanied by a sealed letter containing the author's name, must be sent to the Secretary of the Society before January 1st, 1885. The memoirs may be written in Dutch, French, Latin, English, Italian, or German, but not in the German characters—a very prudent reservation.

Professors Morgen and König ("Landwirth Versuchs. Stat.") find, experimentally, that an addition of 10 per cent of kainite to decomposing horn-powder entirely prevents the loss of nitrogen.

"Science" proposes to utilise the Yellowstone Park as a bison preserve. This animal appears to be much nearer extermination than it has been commonly supposed.

In some countries there prevails an opinion that to secure eggs during incubation from the injurious action of thunderstorms, a piece of iron ought to be placed beneath the nest.

According to "Cosmos les Mondes" a long-haired elephant, larger and more perfect than any specimen hitherto secured, is being extricated from the ice at the mouth of the Lena.

According to Nencki and Sieber ("Berlin Berichte") the hæmine crystals of different animals appear to be identical. The hæmoglobine crystals of different species are, on the contrary, distinct. The hæmoglobine of ox-blood is hygroscopic and deliquescent; that of the raven is sparingly soluble in water. Most hæmoglobines crystallise in the rhombic system, but that of the squirrel in the hexagonal. The authors ascribe these differences to the fact that in different species one and the same colouring-matter (hæmine) is combined with different proportions of an albumenoid, or with different varieties of albumenoids.

According to "Ciel et Terre" tanners predict rain when the liquid in their tan-pits rises to a higher level.

Dr. J. Seegen ("Biolog. Central Blatt") sums up his results on the formation of sugar as follows: they confirm the conclusion that sugar, in a normal constituent of the blood, ranges in dogs from 0·1 to 0·15 per cent. The blood on leaving the liver contains twice as much sugar as that entering the organ. In three animals, weighing respectively 7, 10, and 41 kilos., the quantities of blood issuing from the liver in twenty-four hours were 179, 233, and 423 litres. Consequently 179, 233, and 423 grms. of sugar were daily introduced into the circulation. In the Carnivora this sugar is formed from the albumenoids of the food consumed, the greater part of the carbon ingested being utilised in the formation of sugar. The formation of sugar and its transformation in the blood rank among the chief functions of the mutation of matter.

Miss Adele Fielde confirms the experimental conclusion of Dr. Karl Bülow, that earthworms are able to regenerate portions of lost tissue.

According to "Ciel et Terre" the mean weight of dew deposited nightly is 130 grms. per square metre.

If the water-supply of towns is to be kept wholesome it should be guarded from the access of dogs, as their excreta are the great means of diffusing hydatid disease.

M. Dieulefait, in a communication to the Academy of Sciences, showed that the ash of plants still surviving from the Carboniferous Epoch, especially the Equisetaceæ, growing on the most different soils, contain proportions of sulphuric acid greatly in excess of the quantity found in the ash of plants of the present epoch. This accounts for the presence of large quantities of sulphur and calcium sulphate in all coals.

Professor Carnelley is applying the periodic law in mineralogy.

Mr. H. Carvill Lewis (Philadelphia Academy of Natural Sciences) has observed an interesting case of phosphorescent snow. A mountain covered with this snow shone by night as if illuminated by the moon.

The "Popular Science Monthly," discussing the physical training of girls, pronounces the piano the "domestic vampire."

A Spiritualist writer declares his conviction that even the tapeworm has some important duty to execute.

It is said that 16 per cent of our native blue flowers bloom in April, 14 of the white, 9 of the red, and of the yellow about the same as the red. Some regard this as an inverse spectral order.

According to Dr. Ihreng ("Kosmos") polydactylous horses, with extra toes on the inner side of the fore feet, are occasionally met with in South America. He raises the question whether these are not survivals of an old race of *Equus* which escaped the notice of the Spanish settlers?

"Cosmos les Mondes," which is not the better for the death of its former distinguished editor, the Abbé Moigno, describes itself as in favour of Evolution, not indeed according to Darwin, but to Claude Bernard,—that is, upon à definite plan.

Mr. C. H. Hitchcock ("Science") gives, on the authority of Mr. Leitch, formerly a missionary in Ceylon, a case of a serpent about 7 feet long,—name not given,—which, when being killed, made a loud noise like the bellowing of a bull two years old.

A "prayer meeting" in defence of the vested rights of syphilis has lately been held in Exeter Hall.

M. Sivodot has been elected a "Correspondent" of the French Academy of Sciences in place of the late C. Darwin!

The forests of the United States are composed of 412 species of trees, assignable to 158 genera; 48 of the genera and 60 of the species are peculiar to Florida.

Herr Von Gossler, the German Minister for Education, has issued a series of regulations for experiments upon living animals. These regulations are infinitely wiser than our British Anti-Vivisection Act, but they may be pronounced weak in conceding anything to the Bestiarians. The worst point is that experiments on animals can be conducted only by professors and college-*docenten*, thus shutting out private biologists.

"Light" considers that the witches put to death two centuries ago were in many cases mediums of mischievous human spirits.

"Light" is seemingly not well pleased with our question, anent the Premier's visit to Mr. Eglinton, whether Spiritualism would take up a political character? We submit that it is nothing new for party-leaders to bid for the good will of any body of men which is gaining influence. We should be sorry to see Spiritualism follow the example of Positivism, Secularism, &c., by associating itself with any political party.

"A ghost" may possibly be a four-dimensional being, but, if we admit the existence of four-dimensional space, we may ask whether there may not be material beings who exist and act in such space?

Mr. T. B. Comstock ("Science") seems to include the grizzly bear among the animals to be preserved in the Yellowstone Park.

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